LIESBEECK-BLACK RIVER CONFLUENCE AREA: LAND-USE OPPORTUNITIES AND CONSTRAINTS

by

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Jan Gerhardus Bergman
Cape Town
1994

TERMS OF REFERENCE

This study was initiated by Prof. R.F. Fuggle of UCT's Department of Environmental and Geographical Science on 3 January 1994. The brief of the study was to analyse the opportunities and constraints to development proffered by the environment in the Liesbeeck-Black River confluence area.

His specific instructions were that the study should conform to the academic standards required for the part fulfilment of the Master of Philosophy degree, and that the individual dissertations should *inter alia*:

* demonstrate an ability to deal with problems on an interdisciplinary nature,
* demonstrate resourcefulness in the analysis of data, power of critical assessment and alertness to the significance of results,
* demonstrate an adequate grasp of the principles and techniques for analysing, evaluating and presenting information,
* comprise a logic and coherent account of the project.

The dissertation was required by 17h00 on Friday, 24 June 1994.

EXECUTIVE SUMMARY

This study investigated the land-use potential of the Liesbeeck-Black River confluence area. It is intended to serve as a guide to land-use planners and other interested parties concerning the opportunities and constraints proffered by the environment on the confluence area. The collecting of baseline data was undertaken by nine Masters Students in the Department of Environmental and Geographical Science at the University of Cape Town. Each student then analysed the data individually. The study was undertaken in part fulfilment of the academic requirements of the Masters Degree.

The Liesbeeck-Black River confluence area (hereafter called the study area) is located approximately 5.5 km east of the CBD of Cape Town. It covers approximately 232 ha and is bounded by the N2 Freeway to the South, Alexandra Road to the East, Liesbeeck Parkway to the West and the Culemborg-Black River Railway Yard to the North.

The aim of the study was twofold, firstly to determine a procedure whereby the optimal land-use alternative for an area could be determined, taking into account the effects of significant environmental elements, and secondly to analyse and determine the optimal land-use alternative for the study area specifically.

The procedure developed during the research is an adaptation of the Leopold Matrix method of analysis. The environmental elements characteristic of the study area are listed on the horizontal axis, and the land-use options to be analysed on the vertical axis. The magnitude and significance of the effect of an environmental element on a particular type of land-use can then be rated and this rating entered in the corresponding matrix cell. By adding the ratings of all environmental elements on each land-use option, the overall rating of the different land-use options can be obtained. The option with the highest overall (positive) rating is then considered to be the optimal type of land-use.

This method was then applied to assess the land-use potential of the study area. The land-use options considered to be appropriate for the study area were determined by considering only those types of land-uses for which a regional need had previously been established. These land-use options were:

* Education

* Employment
* Housing
* Public Facilities
* Transportation
* Health Facilities
* Conservation

The Masters Students had previously determined, in the Baseline Study, which environmental elements will influence land-use planning in the study area. The elements applied in the analysis of the study area were:

* Relief
* Geophysical Components
* Hydrology
* Pollution
* Flora
* Fauna
* Transportation Infrastructure
* Wet Services
* Other Utility Services
* Historical Components
* Local Demography
* Land-Owners and Users
* Zoning
* Policies and Plans
* Social Issues and Concerns
* Location

It was problematic to examine the study area as a single unit, as it was found to display a wide range of differing environmental characteristics. The study area was therefore subdivided (on the basis of land-use and ownership) into fourteen separate functional units. The land-use option for which the environment proffered most opportunities and fewest constraints was then determined, using the adapted Leopold Matrix method of analysis, for each functional unit.

The preferred land-use options for the functional units were represented on a map of the

study area. The appropriateness of these options, seen in context of the study area as a whole, was determined and any inappropriate land-use options were then changed, with due regard given to the results of the matrix analyses. A map of the optimal land-use alternatives was then constructed.

The optimal land-use alternatives determined by the analysis for the separate functional units were:

* South African Astronomical Observatory- Public Facilities
* Liesbeeck Sports Grounds- Public Facilities
* Maitland Garden Village- Housing
* Alexandra Care and Rehabilitation Centre- Health Facilities
* Maitland Residential/Commercial Area- Housing and Employment
* Golf Driving Range- Housing
* Site for Proposed Gateway Park Development- Health Facilities
* Raapenberg Bird Sanctuary- Conservation
* Site for University of Cape Town's Homestead Development- Public Facilities
* Valkenberg Homestead- Public Facilities
* Valkenberg Hospital- Health Facilities
* Remainder of Cape Town City Council Owned Property, Western Side of Black River - Conservation
* Remainder of Cape Town City Council Owned Property, Eastern Side of Black River - Education and Conservation
* Vincent Pallotti Hospital- Health Facilities

From the results of the study, it was recommended that:

1. This method of analysis could be useful in informing general land-use planning, provided the rating of environmental elements is undertaken by a multi-disciplinary team, and the input from interested and affected parties (I&APs) is ensured throughout the process.

2. The optimal land-use alternatives established for the functional units should be used to guide future land-use planning for the study area. This would ensure that land-use in the area would take maximum advantage of the opportunities proffered by the environment while minimising negative impacts created by environmental constraints.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

GLOSSARY

Baseline Report: The report that emulated from the Baseline Study.

Baseline Study: A study undertaken on the baseline information of the Liesbeeck-Black River confluence area by nine masters students at the Department of Environmental and Geographical Science.

Central Business District (CBD): The business centre of a city or a town.

Confluence Area: An area where two rivers flow together and become one.

Deconcentration Policy: A policy which aimed at directing development away from existing metropolitan urban centres [De Tolly, 1994].

Environmental Impact Assessment (EIA): The administrative or regulatory process by which the environmental impact of a project is determined [Fuggle, 1992].

Garden City Planning Model: A city planning model developed in 1898 by an Englishman by the name of Ebenhezer Howard. The model envisaged suburbs that had the following attributes:

* Different land-uses were to be separated, and industry in particular was separated from housing.
* Large quantities of public open space.
* Housing densities were low and houses had access to private gardens.

This planning model was introduced to South Africa in 1917 by Richard Stuttaford, a Cape Town City Councillor [Watson, 1993].

Geophysical Elements: Those elements comprising geology, geomorphology and soils.

Gross Domestic Product (GDP): A measure of the total flow of goods and services produced by the economy over a specified period (normally a year) [Barber, 1993].

Hectare: An area of 100m X 100m.

Impacts: The outcome of an action, whether considered desirable or undesirable [Department of Environment Affairs, 1992b].

Integrated Environmental Management (IEM): A philosophy designed to ensure that the environmental consequences of development proposals are understood and adequately considered in the planning process [Department of Environment Affairs, 1992a].

Interested and Affected Parties (I&APs): Individuals or groups concerned with an activity or its consequences [Department of Environment Affairs, 1992b].

Multi-disciplinary Team: A team of people from different professional backgrounds.

Proponent: An individual or group proposing an activity [Department of Environment Affairs, 1992b].

Sustainable Development: Development which meets the needs of the present generation, without compromising the ability of future generations to meet their own need [Department of Environment Affairs, 1993].

Wet Services: Those infrastructure services that concerns water, i.e. water reticulation, stormwater reticulation and water-borne sewerage reticulation.

CHAPTER 1
INTRODUCTION

1.1 A STUDY OF THE LIESBEECK-BLACK RIVER CONFLUENCE AREA

1.1.1 Introducing the Study Area

The Liesbeeck-Black River confluence area, hereafter called the study area, is located approximately 5.5 km east of Cape Town's Central Business District and covers about 232 ha [Masters Class, 1994]. The area is bounded by the N2 freeway to the South, Alexandra Road to the East, Liesbeeck Parkway to the West and the Culemborg-Black River Railway Yard to the North. Figure 1.1 indicates the precise location of the study area.

The study area is subdivided into separate smaller sections, owned and used by different parties. The present land-uses in the study area include residential, commercial, a variety of institutional uses and a conservation area. In general, the area could be considered as having low density development.

1.1.2 Introducing the Study

The Deputy City Planner of Cape Town has stated that Cape Town is "renowned for the drama of its setting, its natural and visual splendour, its wealth as a biological resource, and for its culture and humanity ... (and) has the inherent potential to become one of the world's most livable cities" [De Tolly, 1993:18].

Like most cities in the developing world however, Cape Town is facing development problems that could turn the city into "another Calcutta, and surrender to poverty, despair and political alienation [Keegan, 1993:5]. Fortunately, Cape Town is presently still in the position where well planned development could provide a healthy and stimulating environment for all the inhabitants without imposing unsustainable demands on the resources and ecosystems of the city [Hardoy *et.al.*, 1992].

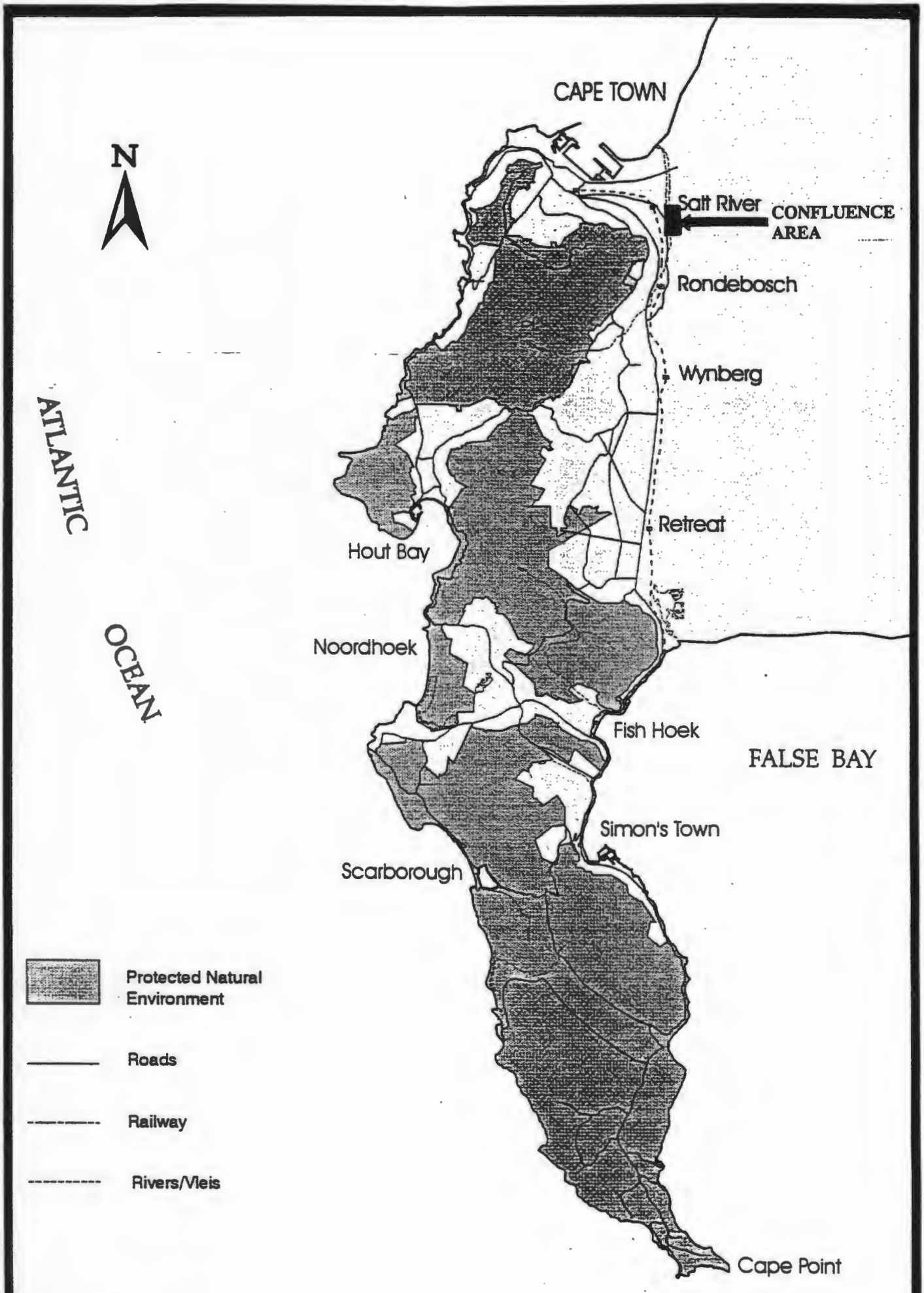

FIGURE 1.1: LOCATION

This study, which deals specifically with the Liesbeeck-Black River confluence area, was initiated by the City Planner's Department as part of their attempt to provide widely debated, holistic development planning for Cape Town. This will contribute to achieving the Cape Town vision of becoming "one of the world's great cities" [City Planner's Department, 1993:2].

1.1.3 The Format of the Study

The study was undertaken over a timespan of six months, which was divided into two separate three month periods. During the first period, research of baseline data was undertaken on the study area by nine students (hereafter termed the Masters Class) reading for the Masters Degree in Environmental and Geographical Science at the University of Cape Town.

The study undertaken by the Masters Class identified and researched all environmental elements characteristic of the study area. The study culminated in a report that described the results of the research. Hereafter, this study will be referred to as the Baseline Study and the report as the Baseline Data Report.

During the second period, the individual members of the Masters Class were required to analyse the data accumulated during the Baseline Study, and produce an academic dissertation in which the details and results of the analysis are described. This dissertation is the result of one such analysis.

1.1.4 Introducing the Report

This dissertation comprises seven chapters. **Chapter 1** comprises the introductory sections, and states the aims and objectives of the study. It also outlines the theoretical underpinnings to the approach and methods used for the study.

Chapter 2 describes the methodology used in analysing the study area.

In **Chapter 3,** the researcher examines the regional development needs and problems of Cape Town. It is argued in this chapter that cognisance of these requirements is essential in determining appropriate land-use alternatives for the study area.

In **Chapter 4** the environmental elements integral to the study area are described. The significance of these elements is also discussed in this chapter.

The impacts of the environmental elements on various land-use options in the study area are analysed in **Chapter 5**. The study area is subdivided into several functional units, and the preferred land-use option for each unit is determined.

Chapter 6 summarises the study and lists the conclusions which can be drawn, while **Chapter 7** recommends how the results of the study should be applied when land-use planning for the study area is undertaken.

1.1.5 Limitations of the Study

The results of the study were limited by a number of factors. While a detailed discussion of the disadvantages of this method of analysis can be found in section 2.6.2, the major limitations are listed below:

a. Limited communication with interested and affected parties (I&APs) regarding the approach and results of the study.

b. The analysis was undertaken by a single researcher which could have introduced unintentional bias to the study. Ideally, a multi-disciplinary team should have undertaken the analysis, but such a team was not available to the researcher.

c. The study did not incorporate any mitigating measures or the possibility of alternative sites for various land-use options. These factors were deliberately omitted as the analysis of mitigation and alternative sites should be the function of an Environmental Impact Assessment undertaken for a specific development proposal.

1.2 AIMS AND OBJECTIVES OF THE STUDY

1.2.1 Aims of the Study

This study had two aims, which were addressed on separate levels.

a. The primary aim of the study was to establish a procedure whereby land-use planning in an urban area could, by taking into account environmental

elements previously identified as exerting an influence on the area, determine the most appropriate form of land-use for that area.

b. The secondary aim of the study was to apply this procedure to the Liesbeeck-Black River confluence area to establish the most appropriate form(s) of land-use for this area.

1.2.2 Objectives of the Study

In fulfilment of the stated aims, the objectives of this study were:

a. To adapt an existing method of environmental analysis in such a way as to make it useful for the purposes of this and future similar studies.

b. To establish the land-use alternatives which should be considered when planning is undertaken for the study area.

c. To determine the environmental elements which would create significant opportunities or constraints for land-use options considered for the study area.

d. To divide the study area into smaller areas (termed functional units) which could then be treated as single planning units.

e. To determine which land-use option is the most appropriate for each functional unit, considering the opportunities and constraints proffered by the environmental elements on the study area.

1.3 LAND-USE PLANNING IN THE URBAN ENVIRONMENT

1.3.1 Introduction

It is possible for cities to provide a healthy and stimulating environment for their inhabitants without imposing unsustainable demands on the natural resources available to the city [Hardoy *et.al.*, 1992]. To ensure that cities (especially those in developing countries which are experiencing rapid urban growth) can develop successfully, strong emphasis on city planing is required to avoid the chaos that so often accompanies such growth [Rivkin, 1976].

It is important for cities that planning provides "a systematic way to manage change and create the best possible future - (planning should be) a creative process for identifying and accomplishing the most important actions in view of strengths and weaknesses, threats and opportunities" [Sorkin *et.al.*, 1983:2].

1.3.2 The Functions of Land-Use Planning

It has been stated that the goal of planning is to improve the quality of life and the general welfare of the community concerned [Claassen & Milton, 1992]. It is the function of all land-use planning to work towards this goal.

Several planning authorities have stated that land-use planning can be divided into two interdependent functions [Claassen & Milton, 1992]. The first function is to determine the ideal arrangement of land-uses in a city. This arrangement is based on "theories derived from scientific and empirical analysis" [Claassen & Milton, 1992:715] and aims to create cities that provide pleasant living environments and are able to function efficiently.

It is, however, difficult to achieve this ideal arrangement of land-uses in any city. This is due to the fact that every city has a changing nature and the inhabitants have conflicting needs and expectations [Davies, 1993]. Perspectives on the urban environment will, for example, be different according to whether they were forged in a crowded and poorly serviced shack settlement or nurtured in a more affluent suburb [Hart, 1992]. This leads to the second function of planning, which is to "provide a fair, just and efficient process of arbitrating between conflicting land-uses" [Claassen & Milton, 1992:715].

1.3.3 Who and What Informs Land-Use Planning

To be successful, a city should strive to provide multiple services [Davies, 1993]. These services include the provision of healthy living and working environments for its inhabitants, the supply of clean water and proper sanitation, refuse removal, stormwater drainage and other forms of infrastructure and services essential for health and for a prosperous economic base. The city should strive to achieve a sustainable relationship between the demands of consumers and the resources from which they draw [Hardoy *et.al.*, 1992].

It would, however, be incorrect to assume that people living within a city necessarily agree on the priority of services which are required. In fact, it is more the case that these priorities are seen in diverse or divergent ways by different groups with particular socio-

economic characteristics and political objectives [Hart, 1992]. For instance, while development agencies such as the World Bank are calling for increased urban economic productivity in developing cities [Hart, 1992], conservationists warn that the growth induced by the capitalist form of development has led to several of the world's environmental disasters [Cock, 1990b].

It is therefore the challenge of land-use planning to provide the forum through which a community can analyse its problems and create mechanisms to address these problems. It is essential that the process by which decisions are taken is fair and democratic so that the will of the majority, and not those of pressure groups, will prevail [Claassen & Milton, 1992].

Land-use planning should therefore be informed by the needs of the inhabitants of the city. Planning should put a structure in place through which the inhabitants can democratically decide the priority of their needs.

1.3.4 The Role of IEM in Land-Use Planning

The principles underpinning the Integrated Environmental Management (IEM) process indicate significant overlap between IEM and the ideals of land-use planning. In its document *The Integrated Environmental Management Procedure*, the Department of Environment Affairs [1992] states that IEM should aim to:

* lead to informed decision-making;
* form an open, participatory approach in the planning of proposals;
* have extensive consultation with interested and affected parties;
* give due consideration to alternative development options;
* attempt to mitigate negative impacts and enhance positive aspects of development proposals;
* show a democratic regard for the rights and obligations of individuals.

If these aims are used to describe the principles of land-use planning, the overlap between the IEM process and land-use planning becomes obvious. Therefore, if land-use planning follows the broad principles of the IEM procedure, the resultant land-use planning should lead to development that is largely sustainable and is acceptable to the majority of inhabitants of the affected community.

1.4 APPROACH TO THE STUDY

This study was not aimed at undertaking an environmental impact assessment of a specific project, but rather at determining opportunities and constraints for various land-use options in the study area. The usual planning procedures determined by the Integrated Environmental Management system, as developed by the Department of Environment Affairs [1992a], therefore needed to be adapted for use in the study. It must be noted however that the broad principles and techniques of IEM still applied and were utilised in the study.

The approach followed in an attempt to achieve the stated objectives of the study are outlined below:

a. By analysing secondary data available to the researcher, regional development requirements and problems of Cape Town were determined.

b. The Baseline Study [Masters Class, 1994] identified the environmental elements characteristic of the study area, and briefly analysed the impact of these elements on the study area. Using the analyses of the Baseline Study, the researcher determined which environmental elements would significantly influence land-use planning in the study area.

c. The study area was subdivided into smaller areas, termed functional units, each of which displayed a smaller range of environmental characteristics than the study area as a whole. Areas that were either owned or used by different parties were treated as individual functional units.

d. Using an adaptation of the Leopold Matrix, the opportunities and constraints proffered by environmental elements on various land-use options in a functional unit were assessed. The significance and magnitude of the opportunities and constraints were determined by the researcher, using the information available on each environmental element.

   Using the matrix for each functional unit, the land-use option for which the most opportunities and fewest constraints were determined was then deemed to be the preferred land-use alternative for that functional unit.

Chapter 2 describes in detail how the original Leopold Matrix was adapted and used for the purpose of this study.

e. A map of the study area was produced indicating the preferred land-use options for each individual functional unit. This map was then used to compare the preferred land-use options of the different functional units. Any land-use options considered by the researcher to be inappropriate, viewed in context of the study area as a whole, were altered. A final consolidated map of the study area was produced indicating the optimal land-use alternative for each functional unit.

CHAPTER 2
EXPLAINING THE METHODOLOGY: DERIVATION OF A MODIFIED LEOPOLD MATRIX METHOD OF ANALYSIS

2.1 THE ORIGINAL LEOPOLD MATRIX

The Leopold Matrix was originally developed in an attempt to ensure that "unquantified environmental amenities are given appropriate consideration in decision-making along with economic and technical considerations" [Leopold *et.al.*, 1971:1]. The matrix listed 100 project actions related to specific development projects along the vertical axis and 88 environmental elements on the vertical axis. A total of 8800 possible interactions between project actions and the environment were thus identified. The matrix is useful in identifying "first-order cause-effect relationships" [Fuggle, 1992:769] when the environmental impacts of a development project were assessed.

2.2 MODIFYING THE LEOPOLD MATRIX

This study was not an impact assessment, but rather a study to determine the opportunities and constraints proffered by the environment on different land-use options in the study area. It was therefore necessary to adapt the original Leopold Matrix in order to use it in the context of this study.

In the case of the modified matrix, the vertical axis listed the different land-use options considered appropriate for the functional unit. Along the horizontal axis the environmental elements characteristic of the functional unit were listed. This matrix thus made it possible to identify the interactions between land-use options and the environment.

2.3 REASON FOR USING THE MODIFIED LEOPOLD MATRIX

The primary reason for using this form of matrix analysis was to determine the optimal land-use alternative for each functional unit, taking the influence of all environmental elements into account. In order to achieve this, the analysis was used to:

a. Determine the effect of an environmental element on a particular type of land-use in a functional unit. This indicated whether the element presented an opportunity or constraint on that type of land-use.

b. Determine the magnitude of the effect of the environmental element on a particular type of land-use in a functional unit.

c. Determine the significance of the effect of the environmental element on a particular type of land-use in a functional unit.

d. Combine the magnitude and significance of the effect of an environmental element to determine the overall effect of that element on a particular type of land-use in a functional unit.

e. Determine the combined effect of all environmental elements on a particular type of land-use in a functional unit.

2.4 USING THE MODIFIED LEOPOLD MATRIX

Each functional unit was subjected separately to the matrix method of analysis. Two matrices were constructed for each functional unit, the Raw Scoring Matrix (refer to Appendix A) and the Consolidated Matrix (refer to section 5.3.4). The different matrices are discussed in sections 2.4.1 and 2.4.2.

2.4.1 The Raw Scoring Matrix

The purpose of this matrix was to determine the magnitude and significance of the effect of an environmental element on a particular type of land-use in a functional unit. Determining which environmental elements were characteristic of the functional units will be discussed in Chapter 4. The cell entries for this matrix were determined as follows:

a. The researcher determined whether an element proffered an opportunity or a constraint on a particular type of land-use. A positive cell entry indicated an opportunity, while a negative entry indicated a constraint.

b. The magnitude of the effect was determined by the researcher and entered in the left-hand side of a cell. The magnitude was rated on a three point scale, where:

1 = low magnitude

2 = intermediate magnitude

3 = high magnitude.

c. The significance of the effect was determined by the researcher and entered in the right-hand side of a cell. Significance was rated on a similar scale to magnitude, as indicated above.

d. When the researcher was unable to determine either the magnitude or significance of the effect of an environmental element, a question mark (?) was entered in the cell. This highlighted areas of particular concern for land-use planning.

2.4.2 The Consolidated Matrix

The purpose of this matrix was to assess the combined effect of the magnitude and significance of each environmental element on a particular type of land-use in a functional unit. It also allowed the researcher to assess the combined effect of all environmental elements on a particular type of land-use in that functional unit. This, in turn, allowed a comparison of the different types of land-uses in a functional unit to be undertaken. The cell entries for this matrix were determined as follows:

a. The magnitude and significance of each environmental element were multiplied to obtain an overall rating for that element. This procedure was established by the Department of Environment Affairs in 1976, and several experts in the field of impact analysis still believe it to be appropriate [Fuggle, 1994].

A positive cell entry indicated the effect to be an opportunity, while a negative entry indicated that it was a constraint.

b. Due to the subjectivity involved in rating the magnitude and significance of the environmental elements, only those elements which showed an overall rating of 4 or higher were entered in the consolidated matrix. This eliminated any influence of elements that were determined to be either of low magnitude or low significance.

c. The ratings for all opportunities and constraints proffered by the environmental elements were added for each land-use option, thereby obtaining a total rating score for each land-use option in a functional unit.

d. The total rating scores for the different land-use options in a functional unit were compared to one another, and the land-use options were then ranked according to these scores. The land-use option which obtained the highest positive score was classified as the most preferred land-use option.

e. Those environmental elements which obtained an overall individual rating of 6 or 9 were considered by the researcher to be of major importance, and were highlighted in the matrix. This assisted in visually identifying which environmental elements had a major influence on the different land-use options in a functional unit.

The land use-use options classified as the most preferred options were then mapped and subjected to a second level of analysis. This process is described in section 2.5.

2.5 MAPPING THE RESULTS OF THE MODIFIED LEOPOLD MATRIX

In order to analyse the study area using the Modified Leopold Matrix method, it was necessary to divide the study area into functional units which were analysed individually. While this allowed for the comparison of different land-use alternatives in a functional unit, it did not allow for the comparison of preferred land-use options between different functional units.

In an attempt to overcome this problem, the preferred land-use option of each functional unit was represented on a map showing the whole study area (refer to Fig.5.1).

A visual inspection of this map was undertaken to determine whether the preferred land-use options for the functional units, seen in the context of the study area, were optimal. If the preferred land-use option of a functional unit was considered by the researcher to be inappropriate (seen in the context of the surrounding land-use options), such an option was changed. Before changing the preferred land-use option for a functional unit, the results of the matrix analysis of that unit were consulted to ensure the new land-use option was not in complete contradiction to the results of the matrix analysis.

A map was then constructed indicating the altered land-use options (refer to Fig.5.2), and these options were considered by the researcher to be the optimal land-use alternatives for the functional units.

2.6 ADVANTAGES AND DISADVANTAGES OF THE MODIFIED LEOPOLD MATRIX

The Leopold Matrix has been criticised by many people involved in the field of impact analysis [Hill, 1993]. It was found, however, that this method of analysis displayed many useful properties when used to analyse the environmental characteristics of the study area. Therefore the original Leopold Matrix was adapted and used for the purpose of the study.

There are, however, a number of disadvantages to this method of analysis. It is important that users of this method are aware of these disadvantages. Special care could then be taken to minimize the impact of the disadvantages on the results of the analysis.

The advantages and disadvantages of the Modified Leopold Matrix method of analysis, as used in this study, are discussed in sections 2.6.1 and 2.6.2.

2.6.1 Advantages

a. The matrix provides a scientific method to analytically determine the most appropriate types of land-uses for the study area.

b. The matrix is simple to construct and easy to use and communicates its information clearly to the user.

c. The matrix is an excellent method for determining which environmental elements create opportunities or constraints on a particular type of land-use. A specific project proposal for a functional unit could then take special care to maximise benefits created by opportunities, and mitigate impacts caused by constraints.

d. The matrix is very comprehensive in listing all environmental elements characteristic to the study area. If required however, it is a simple process to add additional environmental elements to the matrix.

e. It is possible to include additional land-use options, or even specific development proposals, to the matrix. This allows for comparison with the land-use options assessed in the study.

f. The different land-use options assessed for a functional unit are easily comparable as they appear on the same matrix.

g. The ratings determined by the researcher can easily be altered. It is therefore possible to assess how a change in the rating of some environmental elements (e.g. through mitigating measures) would influence the overall ranking of land-use options. Therefore, the matrix does not lead to rigid, blueprint planning but rather presents adaptable planning guidelines.

h. It would be possible to use this method of analysis in determining the land-use opportunities and constraints for the whole Cape Town region. These could then be represented on a computer model (e.g. a GIS system) of the region which would greatly assist future planning for Cape Town. Time constraints precluded the construction of such a model for the study area.

i. By including the significance rating in the analysis, different weighting were ascribed to different environmental elements. Elements that were considered to be more important than others, were given a higher significance rating.

j. The process allows for input from I&APs before and after the effects of the environmental elements were rated. This ensures the final results will be democratic and enjoy a broad support base. Time constraints again precluded the input from I&APs in the rating process of this study.

2.6.2 Disadvantages

a. The researcher assigned the magnitude and significance ratings to the environmental elements. This inevitably resulted in an amount of subjectivity being introduced to the results, even though care was taken to minimize this effect.

Ideally, the ratings should have been determined by a multi-disciplinary team, but time constraints precluded this option from the study.

b. The analysis of different functional units was completed on different matrices. It was therefore problematic to compare the preferred land-use options between different functional units. This problem was, however, overcome by representing the preferred land-use options for the different functional units on a map of the whole study area

Fig. 5.1). It was then possible to judge the appropriateness of the land-use options in the context of the whole study area.

c. This analysis did not take two important factors into account, namely the possible mitigation of constraints and assessing possible alternative, more appropriate, sites for a particular land-use. This should, however, be the function of an Environmental Impact Analysis (EIA) of a specific development proposal.

Furthermore, only those environmental elements whose combined effects were rated 4 or more were included in the consolidated matrix. Any elements whose effects could easily be mitigated were therefore not included in the analysis.

d. It is possible that further bias could have been introduced into the study by double counting of some environmental elements. For example, should flora and fauna have been treated separately, or should they have been combined as one element in the study?

The impact of this problem could again have been minimised by using a multi-disciplinary team to assess the elements. Discussion with I&APs would also alleviate the problem.

e. This method of analysis takes a long time to complete, and requires the input of several people, which could prove to be expensive.

f. The matrix did not explain the reasoning of the researcher in attributing certain ratings to various elements. This problem could have been alleviated by attaching a descriptive section to the matrices. This would, however, have been a very large section and was therefore omitted.

The user should refer to the main document (Chapters 3 and 4) to deduce why ratings were assigned to different environmental elements.

g. Arithmetical manipulation of real numbers was used to determine the preferred land-use options for the different functional units. This could induce the belief that the total ratings for the land-use options could be summed for the whole study area (or parts thereof) to determine one "overall" preferred land-use option for the whole area.

It must be stressed that each matrix should be used only within the context of the appropriate functional unit. As the sizes and environmental characteristics of these units vary, the matrices cannot be added to determine a single preferred land-use alternative for the study area.

Having discussed the reasoning behind using a modified version of the Leopold Matrix to analyse the study area, the land-use options appropriate for the study area will be determined in the following chapter.

CHAPTER 3
DETERMINING APPROPRIATE LAND-USE OPTIONS FOR ANALYSING THE STUDY AREA

3.1 AIM OF THIS CHAPTER

The point of departure of this study is the fact that the study area, due to its location and relative undeveloped state, should be considered as a strategic area by land-use planners. This area, together with other similar areas in the Cape Town region, present major opportunities to the city in addressing its development problems. These areas should therefore be subjected to very careful land-use planning.

In the absence of a clear development framework for the city, it is important that development in such strategic areas should be approved only if a **regional need** for the development has been established [Metropolitan Development Framework, 1993a]. This would ensure that the area is used for the benefit of the majority of Cape Town's residents, and not for the sole benefit of a small group involved with the development [Barber, 1994].

It is the aim of this chapter to determine which land-use options would be appropriate for the study area. This will be achieved by assessing the regional development needs and problems of the Cape Town region. The study will then determine the most appropriate land-use option for the study area for which a **regional need** has been established.

3.2 THE NEED FOR A DEVELOPMENT FRAMEWORK FOR METROPOLITAN CAPE TOWN

> *"Is the future of the world system bound to be growth and then collapse into a dismal, depleted existence? Only if we make the initial assumption that our present way of doing things will not change."*
>
> *[Meadows, 1974:127]*

When the impacts of a proposed development are assessed, it is important to include assessing the proposal in its "regional context" [Callaghan, 1993], or in other words, whether

it fits in with the regional development plan of the city [Barber, 1994]. If this is not undertaken, planning could lead to so called *ad hoc* development. There is general agreement amongst planning professionals that *ad hoc* developments have resulted in many of the problems currently facing Cape Town [De Tolly,1994].

Without a regional development framework, development proposals that provide short term benefits may be approved without assessing their possible long-term impacts on the form of the city. For example, ways of overcoming people's dependence on the motor car for transportation is currently the subject of widespread debate [Watson, 1993]. Despite this debate, large sums of money are presently being spent on the widening of the N2 Freeway. If a policy is approved that encourages people to use public transportation more frequently, traffic volumes on existing roads should decrease and widening of freeways would not be required.

It can therefore be confidently stated that in the absence of a clear development framework for Metropolitan Cape Town, the regional impact of a development proposal cannot be adequately assessed. Thus the problem of *ad hoc* development in Cape Town will be compounded, possibly resulting in a "city that once held within it the potential for greatness, and let all that go" [Keegan, 1993:5].

3.3 IMPORTANT CONSIDERATIONS FOR DEVELOPMENT PLANNING IN CAPE TOWN

Cape Town, as a major city in a developing country, needs to develop if it wishes to cater adequately for its residents and contribute to the wellbeing of this country [Metropolitan Development Framework, 1993b]. At present, the Cape Town metropolitan area is "characterised by widespread poverty and inequitable access to available metropolitan resources" [Metropolitan Development Framework, 1993a:5]. Cape Town's need for development was underlined by the Urban Foundation's estimate [1993] that approximately 80 per cent of the future Gross Domestic Product (GDP) growth in developing countries will originate in cities.

The growth of Cape Town has become an inevitable reality, and proper management of the city therefore becomes increasingly important. As shown by cities such as Hong Kong, Singapore and Seoul, it is possible for rapidly growing cities to function effectively provided they are well managed [Urban Foundation, 1993]. On the other hand, cities such as Calcutta, Lagos, Teheran and Kinshasa are described as some of the "world's worst managed

cities" [Urban Foundation, 1993:6] and there are near complete breakdown and disorder in the structure of these cities [Urban Foundation, 1993].

For the management of Cape Town to be effective, the goals of managing the city should be defined. As stated by the deputy Planner of Cape Town, a vision for the future of Cape Town is needed as "we need to know where we would like to go before we can plan the best way of getting there" [De Tolly, 1993:19]. The City Planner's Department has proposed a vision which is simply "to make Cape Town one of the great cities of the world" [City Planner's Department, 1993:2].

It is important, however, that the development framework should not become too prescriptive in its application; it should stay flexible to avoid further planning problems. It has been argued that structural problems of the South African city were caused by the "pervasively held notion that most planning problems were essentially technical and that there was one best solution for all problems" [McCarthy & Smit, 1984:8]. This led to planning in the form of rigid blueprints, causing several long-term planning disasters [Watson, 1993]. For example, the garden city planning model, which advocated cities with "large open spaces, low housing densities, separate land uses, mono functionality and self containment" [Murley, 1993:21] suited the ideals of the apartheid government between 1948 and 1993 and was used for the purpose of "residential segregation and social control" [Watson, 1993:39]. Thereby the unique and costly problems of the racially segregated city were created that present city planners must deal with [Todeschini, 1993].

The challenge to city planning for Cape Town therefore becomes to cater for the basic needs of all its residents, yet ensuring this does not lead to other long-term problems. It is therefore important that land-use planning within the boundaries of the Cape Metropolitan area, for example with respect to the Liesbeeck-Black River confluence area, is undertaken within the context of a regional development framework and aims to achieve the ideal vision of Cape Town.

3.4 PLANNING IN THE INTERIM

Establishing a development framework which would be acceptable to all inhabitants of Cape Town should be the result of broad debate, with input from as many interested parties as possible [Metropolitan Development Framework, 1993b]. The process would be further complicated by the fact that cities are complex, and are resistant to a single view, "no matter how poetic, humanistic or sensible that view may be" [Van Wyk, 1993:7].

It is therefore clear that a development framework for Cape Town will not be in place within the immediate future. It is also true that development in Cape Town should not be brought to a complete standstill until such a framework is in place [Metropolitan Development Framework, 1993a]. The question thus becomes how development planning should proceed in the interim, before a final development framework for the city is in place.

The Western Cape Economic Development Forum [1993] has proposed an *Interim Metropolitan Development Framework* to "guide essential changes needed to restructure and manage the Cape Metropolitan Area" [Metropolitan Development Framework, 1993b:1]. They suggested that "key metropolitan stakeholders should have as their primary commitment ... (the) addressing (of) critical issues now, (that is) continue existing work and initiate work which addresses urgent community needs and (which) cannot be postponed..." [Metropolitan Development Framework, 1993a:14]. Similar sentiments were expressed by Watson [1993], De Tolly [1993] and Gubb [1994].

It is thus argued that for any development proposal in a strategic area of Cape Town (as defined in section 3.1) to be approved, a regional need for that development should be established. This would ensure that development in the short term will not be in conflict with a long term development framework for the city. In the context of this study, the study area will therefore be assessed in terms of only those land-use options for which a regional need was established.

3.5 DEVELOPMENT CONSIDERATIONS OF METROPOLITAN CAPE TOWN

Uncoordinated planning has left Cape Town with many structural problems that present and future city planners must address [Watson, 1993]. Studies by the Urban Problems Research Unit [1990], Cock [1990b], Durning [1990] and the Metropolitan Development Framework [1993a&b] identified the following problems as inherent to the city:

3.5.1 Rapid Population Growth

Huntley *et.al.* [1989:48] predicted that by the year 2000, South Africa's urban population would have increased from 16,33 million in 1985 to 35,7 million. For Cape Town, the population in the same period is expected to increase from approximately 1,7 million to 3,8 million [Urban Problems Research Unit, 1990:15].

This tremendous increase in the city's urban population will continue to place great demands on the resources of the city such as land, water, housing, infrastructure and skilled manpower [Huntley *et.al.*, 1989:51].

3.5.2 Unemployment, Lack of Income and Poverty

A member of the ANC Western Cape Regional Executive Council stated that "if the major cities of the country are economically efficient, the macro-economy of the country performs well" [Davidson, 1993:47]. He added that the present economic efficiency of South African cities is extremely low. It is therefore important for both the city and the rest of the country that the local economy of Cape Town be stimulated. The same sentiments were expressed by a Cape Town Alderman who believed that the "enemy of conservation in (Cape Town's) society is poverty and depravation" [Keegan, 1993:4].

An estimate of job demand versus formal job supply indicated that by the year 2000, up to 37% of employable people (about 579,000), will not be employed in the formal job market [Urban Problems Research Unit, 1990:34]. It is expected that most of these people will have few trained skills, little or no formal education and will be from the poorest sector of the population [Urban Problems Research Unit, 1990]. The potential impact of such a large number of unemployed people in the city is reason for grave concern [Davies, 1993].

3.5.3 Housing Problems

The housing crisis in Cape Town is not a unitary problem, but comprises a number of facets. These are discussed below:

3.5.3.1 Inappropriate Location

The reason people move to metropolitan areas is to gain access to the facilities provided by a city, such as employment, health, education and other social services.

In Cape Town, as in other South African cities, the apartheid planning model promoted "the spread of low density, mass housing schemes for the lower income groups, (resulting) in the poorest sector of the population being located furthest away ... from the opportunities offered by the city" [Urban problems Research Unit, 1990:53, 54]. Therefore the poor are affected the worst in terms of financial and time costs to overcome this distance.

For example, from Khayelitsha, it costs on average R42 per month to get to the City Bowl by train, while it costs R140 and takes 55 minutes by minibus [City Planner's Department, undated:1]. This translates into approximately 20 per cent of the monthly income of an average family living in Khayelitsha [Urban Problems Research Unit, 1990].

3.5.3.2 Unacceptable Health and Safety Conditions

The main causes of this problem are overcrowding, inadequate utility services (such as access to clean water and sanitation) and the inadequacy of dwellings to provide adequate shelter.

3.5.3.3 Poor Environmental Quality

Cape Town's low income areas perform extremely poorly in terms of environmental quality [Urban Problems Research Unit, 1990:66]. In terms of the natural environment, these areas are often located where there is a high water table. Strong winds and sandy soils make it difficult to construct a dwelling and this leads to unpleasant living environments.

In terms of the built environment, most of the lower income townships are "drab, monotonous, uni-functional areas with few public facilities and are characterised by large tracts of derelict open space" [Urban Problems Research Unit, 1990:66].

3.5.3.4 Insufficient Housing

While it has been stated that the nature of Cape Town's housing problem cannot simply be equated to a shortage of units, it cannot be denied that there is an absolute shortage of houses in Cape Town [Urban Problems Research Unit, 1990]. It has been estimated that between 309,000 and 493,000 units will be required by the year 2000 [Riley, 1988]. This translates to an annual supply of between 26,000 and 41,000 units, compared to the current output of 10,000 to 14,000 units per annum [Urban Problems Research Unit, 1990:68].

The housing problem must urgently be addressed by the city planners, and it is presently one of the most politicised problems surrounding the city. It also remains a fact that people's basic needs, such as housing, must be addressed before any higher order needs can be discussed.

3.5.4 Injudicious Land Utilisation and Restricted Access to Land

Lateral sprawl of the city is a major problem facing Cape Town. Young [1993] estimated if the current rate of sprawl continues, Darling and Malmesbury will be suburbs of Cape Town by the year 2010. The current problem is highlighted by Figure 3.1 which shows the size of Cape Town relative to of other large cities projected on a map of the Cape Peninsula.

The provision of residential land has largely determined the pattern of lateral growth of Cape Town [Urban Problems Research Unit, 1990]. This pattern was influenced by four factors:

a. An emphasis on large-scale projects by both state bodies and private developers who held the view that larger development projects reduced management and construction costs. Because of the scarcity of large portions of open land in the city, development was continuously focused beyond the urban fringe.

b. The Group Areas Act which zoned entire areas of land in the city for particular race groups. Because separation zones between different group areas was seen as advantageous, lateral spread of the city was promoted.

c. The deconcentration policy aimed at "slowing growth in the major metropolitan areas by directing growth towards deconcentration points located at the outer periphery of the metropolitan areas" [Urban Problems Research Unit, 1990:88]. In Cape Town, the creation of Atlantis was an example. This promoted the lateral sprawl of the city as Atlantis was not self sufficient, thereby extending Cape Town's metropolitan area. Secondly, Atlantis intensified the pressures for development of Cape Town in a northern direction.

d. Present town planning practices, still based on the "garden city" model of city development, are contributing to the lateral spread of the city. The problem is compounded by three factors:

    * The concept of a single dwelling on a separate plot.
    * Unnecessary large open spaces attached to public areas (recreational open spaces, schools, hospitals) which lead to low density development.
    * Any residential development is treated as a new development, and is therefore not integrated with existing residential areas.

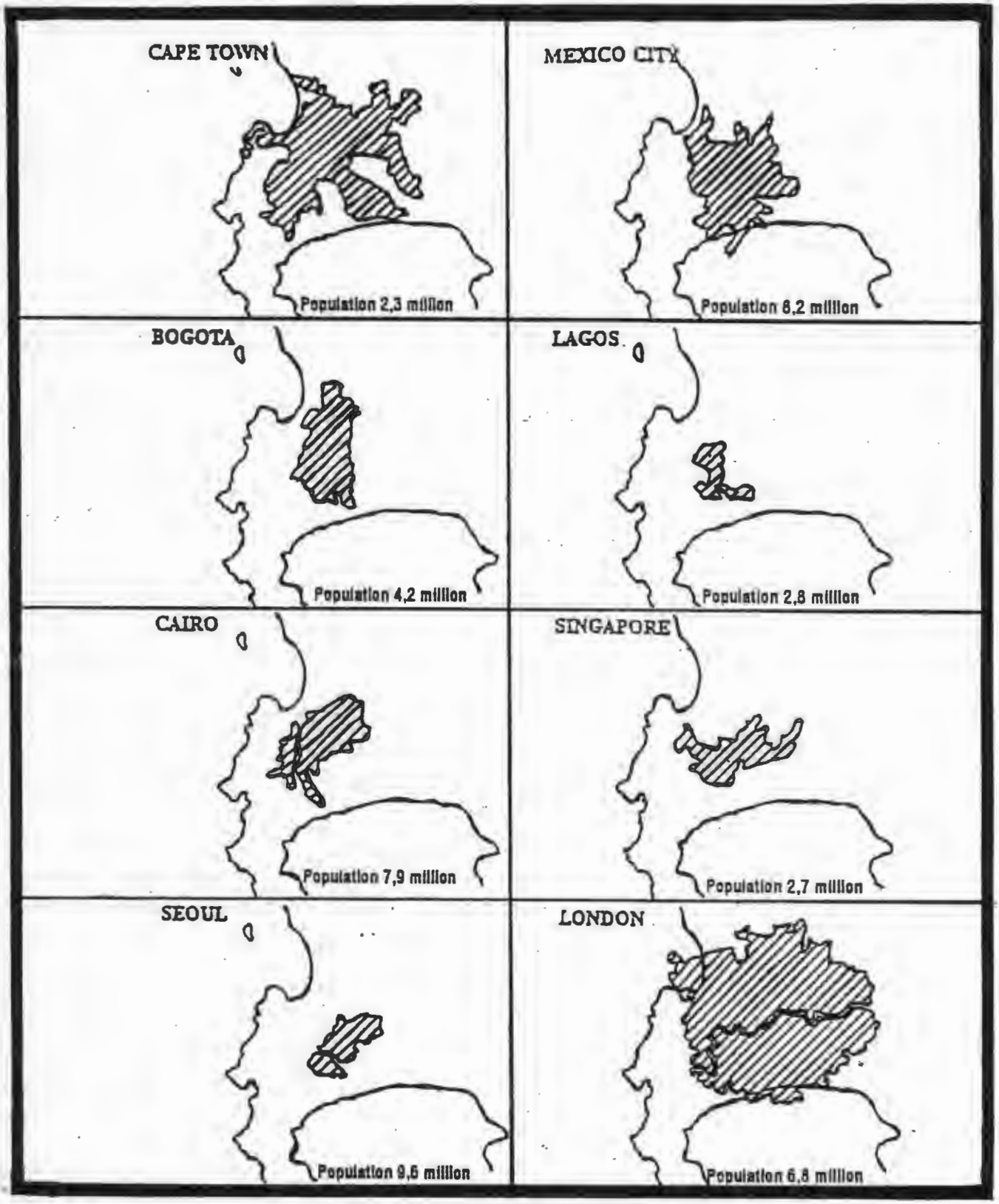

FIGURE 3.1: PATTERN OF LAND CONSUMPTION - CITY SIZE COMPARISON
(Source: Watson [1993:41])

3.5.5 Transportation Problems

Development of the transportation infrastructure of Cape Town is based on the premise that every family owns at least one motor car. This has changed the pattern of both city development as well as the transportation infrastructure. Ever widening freeways, extending into increasingly distant suburban residential areas are striking features of Cape Town [Watson, 1993].

For those who cannot afford a private vehicle, mobility is very difficult. This means that these people, who are the majority of Cape Town's residents , have to rely on public transport in the form of busses, trains or mini-bus taxis for transportation [Urban Problems Research Unit, 1990]. This has had profound financial implications for the urban poor, both in terms of monetary and time costs.

3.5.6 Health Problems

The study undertaken by the Urban Problems Research Unit [1990] indicated severe health problems among the poor communities of the city. The study indicated a definite relationship between material well-being and environmental conditions on the one hand, and health on the other.

Another important factor indicated by the same study is that there is an inequitable distribution of health facilities in Cape Town. This resulted in the poorest sector of the community having the most limited access to health facilities.

3.5.7 Degradation of the Biophysical Environment

"It is widely acknowledged that the site of metropolitan Cape Town - a combination of spectacular mountains and coastlines, sandy plains, numerous water bodies and a unique flora - is amongst the most beautiful in the world" [Urban Problems Research Unit, 1990:130].

Dewar [1991] stated that urban systems, of which Cape Town was no exception, made three types of demand on their natural surroundings. Firstly there was the extractive demand generated by people's daily need for clean water, food, air, minerals and energy. The second was an absorptive demand that the liquid, solid and gaseous wastes produced by people be broken up and absorbed by the environment. The third was the expansive demand to accommodate growth of the city.

The environmental resources threatened by these demands are land, water, air, and natural vegetation.

a. Urban sprawl is the result of low density residential development in Cape Town. This places the available land in and around the city, which includes valuable agricultural land, under stress.

b. Both quality and quantity of **water resources** are threatened by uncontrolled urban expansion. It has been estimated that by the year 2010, the total annual water demand in Cape Town will be approximately 469 million m^3. The total estimated supply will then be 442 million m^3 [Department of Water Affairs, 1986]. The future water demand is clearly a factor that a regional development framework must address.

c. **Air** pollution in Cape Town is caused mostly by vehicle emissions [Urban Problems Research Unit, 1990]. The Cape Town metropolitan area is, however, well ventilated by prevailing winds which helps to alleviate the problem [Urban Problems Research Unit, 1990].

d. The **natural vegetation** around Cape Town is threatened by two factors. The first is the relentless lateral growth of the city, and the second the desperate struggle of the urban poor to satisfy their basic needs [Dewar, 1991]. It is inevitable that people who do not have access to alternative forms of energy or building materials, would take it from the natural environment, leading to the degradation of Cape Town's natural vegetation [Dewar, 1991].

3.5.8 Inequitable Public Facilities

With the increase in densities of residential areas, open spaces and other public facilities play an important role in the lives of the residents of the city. It is important in "providing psychological relief from urban intensities [and] for providing for recreational needs" [Watson, 1993:46]. Apart from recreational open space, other facilities such as sport and community facilities need to be provided. For example, it has been shown that there is an unequal distribution of community sport facilities in the Cape Town Metropolitan Region [Aberman, 1993a] which should be addressed. It is also important that open space in residential areas be developed for the use of the public, otherwise these may turn into "desolate wastelands" [Watson, 1993:46].

3.5.9 Educational Problems

The low level of education in the country is leading to many of the problems facing South African cities today [Durning, 1990]. The problem of lack of access to educational facilities was highlighted as one of the priorities the new regional government of the Western Cape should address [Viljoen, 1994]. It is widely believed that a higher level of education of the majority of South Africans is a prerequisite for addressing problems such as population growth, unemployment and environmental degradation [Hartshorne, 1990].

3.6 LAND-USE OPTIONS IN CONTEXT OF THE LIESBEECK-BLACK RIVER CONFLUENCE AREA

In the previous section, problems with regard to major development issues facing the city of Cape Town were outlined. The challenge of development planning is now to reconstruct Cape Town so that it generates positive urban qualities, become efficient, convenient and rich in opportunities and services and responds sensitively to the natural environment [Dewar, 1991].

The study area, due to its location and present state of low density development, should be subjected to sensitive land-use planning. The public outcry against the Courtyard Development of the University of Cape Town [Masters Class, 1994] emphasised the opposition which insensitive developments would encounter.

In the absence of a clear development framework for the Cape Town region, this study will only consider those land-use options for which a regional need has been identified as appropriate for the study area.

On the basis of the problems discussed in section 3.5, a regional need for the following land-use options, which could be addressed by land-use planning in the study area, has been identified:

a. **Education** which could include formal educational institutions (schools, universities, technicons) or informal educational areas such as outdoors (natural) classrooms.

b. **Employment** which encompasses both formal employment (e.g. industrial development) or providing informal employment opportunities.

c. **Housing**, especially the need for affordable housing for the urban homeless.

d. **Public Facilities** which could take the form of public open space, recreational facilities, sports facilities or community facilities.

e. **Transportation** where a great need has been established for public transportation, including both road (busses and taxis) and rail transportation.

f. **Health facilities** are required to improve the access of the urban poor to such facilities.

g. **Conservation** of the natural and cultural environment is an important land-use consideration.

These land-use options will be evaluated in terms of the opportunities and constraints identified for the study area. By considering only these options, land-use planning for the study area will attempt to address the needs of the broader Cape Town community, and not just benefit a small group of select people. A wider support base for such planning is thereby ensured.

In the following chapter, the environmental elements which will influence land-use planning in the study area will be discussed.

CHAPTER 4
DETERMINING THE SIGNIFICANT ENVIRONMENTAL ELEMENTS OF THE STUDY AREA

4.1 AIM OF THIS CHAPTER

The environmental elements characteristic of the study area are important as they proffer either opportunities or constraints on the land-use options for which a regional need was identified in the previous chapter. This study will use those elements deemed to have a significant impact on land-use planning to assess which land-use options are preferable for the study area.

The aim of this chapter is to provide a brief synopsis of the environmental elements identified by the Baseline Study as characteristic of the study area. The significance of these elements to land-use planning in the area will be highlighted in the chapter.

4.2 THE ENVIRONMENTAL ELEMENTS

4.2.1 Location and Size of the Study Area

Although location is not an environmental element *per se*, it was regarded as an important factor and one which land-use planning should consider. It was therefore included in the analysis.

The study area is located approximately 5.5 km east of the CBD of Cape Town (Figure 1.1), and covers about 232 ha [Masters Class, 1994:1].

4.2.2 The Physical Environment

Through the Baseline Study it was determined that several elements relating to the physical environment would influence land-use planning in the study area. It was therefore deemed important that these elements should be considered in land-use planning, as it would

determine the opportunities and constraints proffered by the physical environment on various land-use options.

The physical elements identified and researched in the Baseline Study were relief, climate, geophysical elements (i.e. geomorphology, geology and soils) and hydrology. The findings of the Baseline Report are summarised below.

4.2.2.1 Relief

The study area has a gentle, undulating relief with a maximum slope of 10 percent. The altitude of the study area ranges from 1.7m (along the river banks) to 12m (at Valkenberg east) above mean sea level. Due to the gentle slope, relief appeared on inspection to have little negative impact on land-use options for the study area.

4.2.2.2 Climate

The study area is characterised, as is the rest of Cape Town and its environs, by a Mediterranean climate (warm dry summers and cool, wet winters). In general, the climate will have no greater influence on land-use options in the study area than it does on the rest of Cape Town. The study area is at times however, subjected to winds of up to 60 km/hr, which land-use planning should consider in terms of human comfort [Masters Class, 1994].

4.2.2.3 Geophysical Elements

An engineering firm is in the process of undertaking a geophysical survey of the area. The Baseline Study did, however, establish that the north western corner of the study area (i.e. Liesbeeck Sports Grounds) was originally a wetland which was reclaimed through infilling with material including builder's rubble, ash and other wastes. Further studies will be required to determine the full potential of the study area in terms of the geophysical elements.

4.2.2.4 Hydrology

Large sections of the study area are located on a floodplain and subjected to regular flooding during winter (Figure 4.1). The flooding potential was therefore identified by the Baseline Study as one of the major physical elements that will influence land-use planning for the study area.

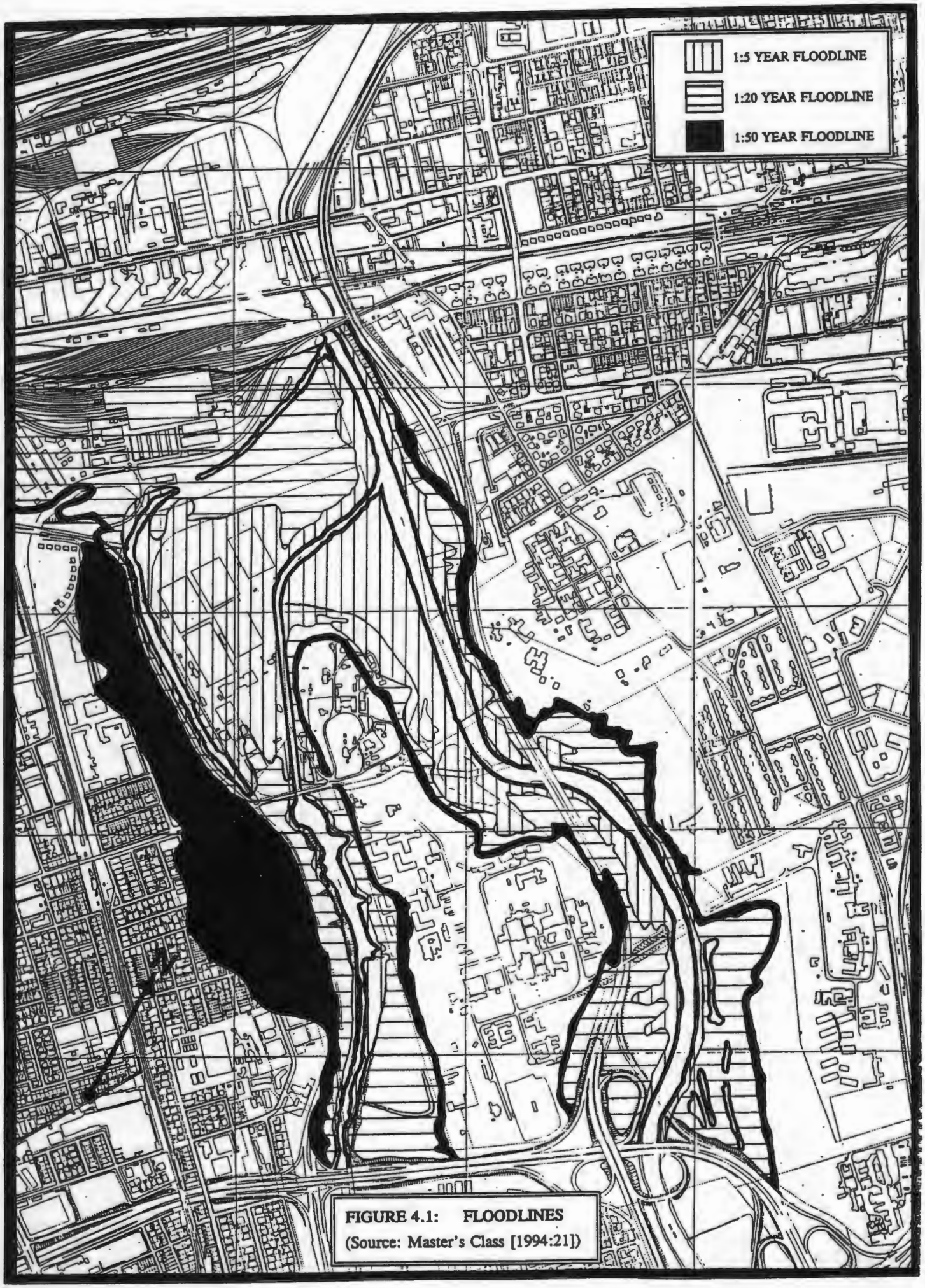

FIGURE 4.1: FLOODLINES
(Source: Master's Class [1994:21])

A study undertaken by MacDonald [1991] supported the observation that flooding of the Black and Liesbeeck Rivers would have a major influence on land-use options in the study area. Davies and Luger [1993] further supported the observation when they described the "power in flood" of the Liesbeeck River.

4.2.3 Pollution

The study area is bordered on three sides by major roads, and this contributes to local air pollution. The traffic volumes along these roads also cause a problem of excessive noise in parts of the study area.

Potential problems with terrestrial pollution are caused by the dump material found in the Liesbeeck Sportsgrounds area. Litter is another common form of pollution in the study area.

The Baseline Study indicated the waters of both the Black and Liesbeeck Rivers to be badly polluted, and that neither should be used for recreational purposes that require contact with the water.

4.2.4 The Biological Environment

The Baseline Study investigated the flora and fauna encountered in the study area. Their significance was determined in terms of their importance to conservation in the Cape Town region.

4.2.4.1 Flora

It was found that most of the study area's flora consisted of alien species, and was therefore of little floristic value. The only area considered to be of botanical interest, and therefore conservation worthy, was the 30 ha of wetlands located in the study area.

4.2.4.2 Fauna

The Baseline Study identified a diverse population of avifauna (i.e. birds) which inhabited mostly the wetland areas. These areas were also found to provide an important temporary feeding ground for various populations of migratory birds. In terms of faunal conservation, the Baseline Study indicated the wetland areas as significant.

4.2.5 Infrastructure

The Baseline Study found that existing infrastructure around the study area will play an important role in land-use planning for the area. Analysis of the infrastructure was divided into transport infrastructure, water carrying (wet) services and other utility services.

4.2.5.1 Transport Infrastructure

The study area is bordered on three sides by major roads, all of which experience heavy traffic congestion during morning and afternoon peak hours.

Several rail routes converge in the vicinity of the study area. Railway stations close to the area include Observatory to the west, Koeberg to the north, Maitland to the northeast and Pinelands to the east.

4.2.5.2 Wet Services

The supply of potable water to areas around the study area is well developed. Problems have, however, been encountered with the sewerage reticulation in the area. This is especially a problem during winter when stormwater enters the system causing a sewage overflow.

Stormwater management is a major problem in the area. Both the Black and Liesbeeck rivers are used as stormwater conduits and regularly flood during winter. This problem will become progressively larger as residential densities in the catchment areas increase.

4.2.5.3 Other Utility Services

There is sufficient capacity on both the telephone and the electrical reticulation systems to serve the study area. There is also a main gas line nearby which could serve the area.

4.2.6 The Socio-Economic Environment

One of the basic principles underpinning IEM is that the meaning of the term *environment* should be broadly defined to include social, economic, cultural and historical elements [Department of Environment Affairs, 1992]. If the concept of sustainable development is

an aim of land-use planning, it is important that these socio-economic elements are included in the factors which direct land-use planning.

This section addressed those elements which comprise the socio-economic environment. These elements were history and archaeology, local demography, recreation and security.

4.2.6.1 History and Archaeology

There are several important historical sites located in and around the study area. These include the buildings of Valkenberg Homestead, Valkenberg Hospital, South African Astronomical Observatory and Alexandra Care and Rehabilitation Centre. The Baseline Study found the study area to be of great historical significance which should be taken into account when land-use planning for the study area is undertaken.

4.2.6.2 Local Demography

The study area is located close to one of the most important employment area in Cape Town, with an average job-population ratio of three jobs for each resident in the area [Aberman, 1993].

Another factor to consider under this element is the price of land in areas surrounding the study area, which ranges from R90 - R488/m^2. Therefore acquiring land within the study area would be expensive.

4.2.6.3 Recreation

The baseline study found a lack of recreational facilities in the greater Cape Town region. However, the study area is located in a part of the Cape Town region which has a very high proportion of sports facilities (a facility to people ratio of approximately 1:5 [Aberman, 1993]).

4.2.6.4 Security

The incidence of crimes reported from the study area were found to be proportionately no higher than the rest of Cape Town. Some security problems have however occurred as large parts of the study area were undeveloped and unused by the general public.

4.2.7 Land-Use and Ownership

There are eleven different groups who own sections of the study area. There are also several different users occupying sections of the study area. This will complicate land-use planning in the study area.

The landowners, who have legal title to their property, have different aspirations for the future use of their properties. The study area could therefore not be considered as one single unit, as the rights and aspirations of each owner need to be considered. Table 4.1 and Figure 4.2 indicate which land-owners and users were represented in the study area.

4.2.8 Zoning

Zoning is the means by which land-uses within an area are legally determined by the local authorities [Cape Provincial Administration, 1985]. While it is possible to have a zoning changed, the procedure would be complicated [Claassen & Milton, 1992]. Zoning could therefore significantly influence land-use planning in the study area. Table 4.1 indicates the different zoning categories imposed on the study area.

4.2.9 Land-Use : Policies and Plans

The Baseline Study identified several planning proposals and documents which influenced the study area in some way. It should be noted that no detailed planning proposals or policies pertaining to the study area were identified.

4.2.10 Social Issues and Concerns

A part of the Baseline Study was directed at selecting and interviewing interested and affected parties (I&APs) to determine their concerns regarding land-use planning for the study area.

The importance of including social concerns in land-use planning was stressed by Cock [1990b] who stated that planning affects a broad spectrum of interests and often generates conflict. Khan [1990] supported this argument by explaining that planning should take cognisance of its social impacts, and should be sensitive to the needs of the affected community.

LAND-OWNER	LAND-USER	ZONING
CAPE TOWN CITY COUNCIL	UNUSED AT PRESENT	COMMUNITY FACILITIES USE
CAPE TOWN CITY COUNCIL	ROAD RESERVES	STREET PURPOSES
CAPE TOWN CITY COUNCIL	RIVERS	LAND COVERED BY WATER
CAPE TOWN CITY COUNCIL	OPEN SPACE	PUBLIC OPEN SPACE
CAPE TOWN CITY COUNCIL	RAAPENBERG BIRD SANCTUARY	COMMUNITY FACILITIES USE
CAPE TOWN CITY COUNCIL	GOLF DRIVING RANGE	SINGLE DWELLING RESIDENTIAL
CAPE TOWN CITY COUNCIL/ PRIVATE	MAITLAND GARDEN VILLAGE	SUBDIVISIONAL AREA
DEPARTMENT OF COMMUNITY DEVELOPMENT	VALKENBERG HOSPITAL (WEST OF BLACK RIVER PARKWAY)	COMMUNITY FACILITIES USE
DEPARTMENT OF COMMUNITY DEVELOPMENT	VALKENBERG HOSPITAL (EAST OF BLACK RIVER PARKWAY)	UNDETERMINED
DEPARTMENT OF COMMUNITY DEVELOPMENT	(LEASED BY) UNIVERSITY OF CAPE TOWN	COMMUNITY FACILITIES USE
DEPARTMENT OF COMMUNITY HEALTH AND WELFARE	ALEXANDRA CARE AND REHABILITATION CENTRE	COMMUNITY FACILITIES USE
FOUNDATION FOR RESEARCH DEVELOPMENT	SOUTH AFRICAN ASTRONOMICAL OBSERVATORY	COMMUNITY FACILITIES USE
MEDICAL RESEARCH COUNCIL	GATEWAY PARK DEVELOPMENT	GENERAL COMMERCIAL
NATIONAL MONUMENTS COUNCIL	VALKENBERG HOMESTEAD	GENERAL BUSINESS
VINCENT PALLOTTI HOSPITAL	VINCENT PALLOTTI HOSPITAL	COMMUNITY FACILITIES USE
TRANSNET	LIESBEECK SPORTSGROUNDS/ RIVER CLUB	COMMUNITY FACILITIES USE
TRANSNET/PRIVATE	MAITLAND RESIDENTIAL	GENERAL RESIDENTIAL
UNIVERSITY OF CAPE TOWN	COURTYARD DEVELOPMENT	COMMUNITY FACILITIES USE
PRIVATE/COMMERCIAL	MAITLAND RESIDENTIAL/ COMMERCIAL	GENERAL COMMERCIAL

TABLE 4.1 : LAND-OWNERS, LAND-USERS AND ZONING

(Source: Masters Class [1994:73, 89])

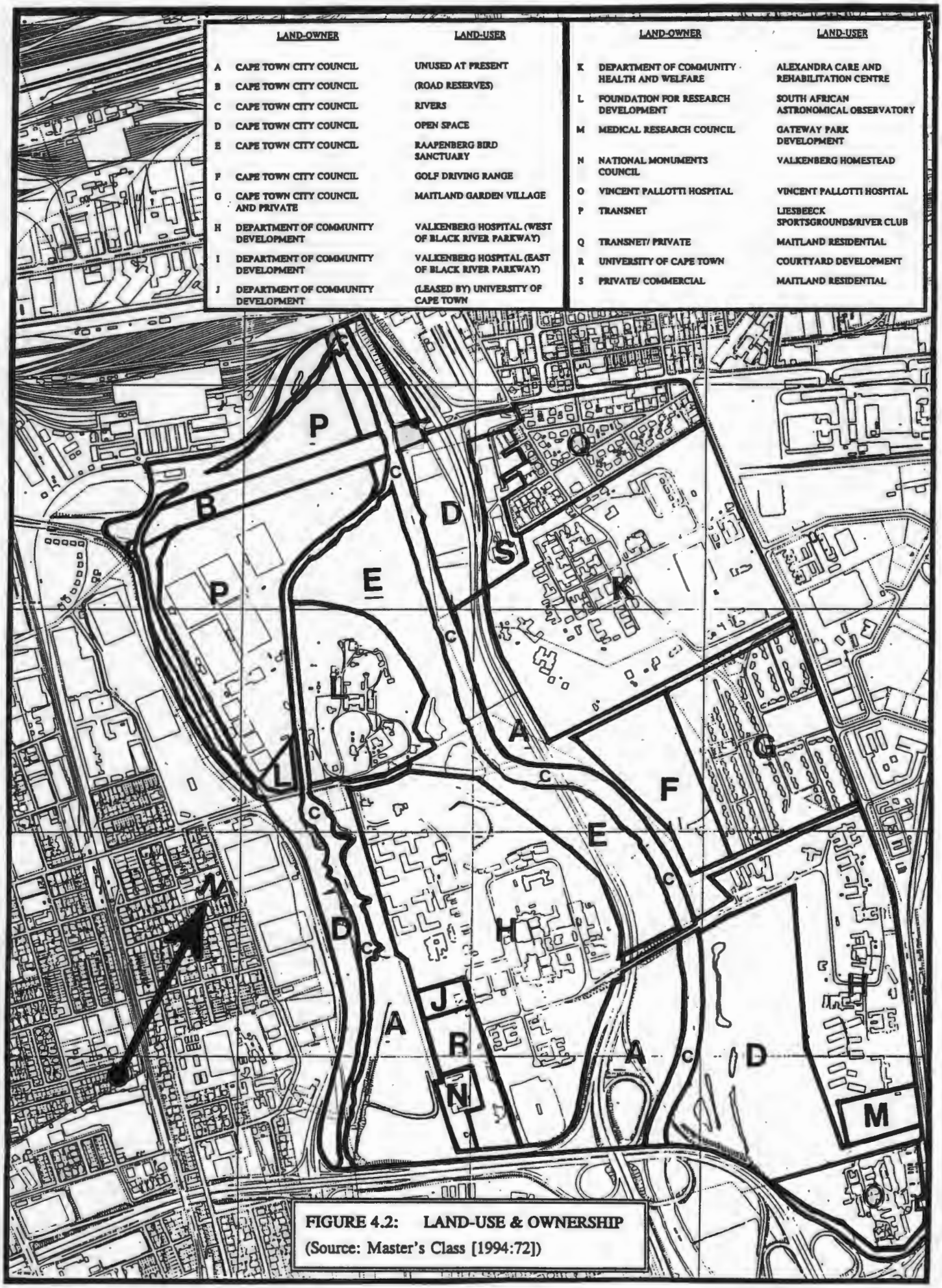

FIGURE 4.2: LAND-USE & OWNERSHIP

(Source: Master's Class [1994:72])

Through interviewing the I&APs, the Baseline Study identified the following issues as the cause of most concern:

a. There was agreement amongst the I&APs that planning in Cape Town, on both the local and metropolitan scales, was inadequate in its present form and should be improved.

b. Current land-use and ownership were important elements influencing decision making in the study area. There were conflicting views as to whether the present land-owners and users should be allowed to occupy the area in the future (e.g. Valkenberg Hospital). The future use and disposal of public land (including land owned by Transnet) was frequently raised as a concern.

c. There was agreement that flooding of the Black and Liesbeeck Rivers was an important element influencing land-use planning for the study area.

d. The I&APs generally agreed that open space areas within a city were important, and the usefulness of the study area in this regard should be carefully assessed. The issue of funding of open space areas concerned several I&APs who believed there was little money available for this purpose. Similar concerns were expressed when the issue of conservation was raised with the I&APs.

e. The I&APs generally agreed that the historical elements in the study area were worthy of conservation and should be maintained.

f. There was agreement amongst the I&APs that all interested parties, at both a local as well as a metropolitan level, should be consulted when land-use planning for the study area is undertaken.

g. Many of the I&APs interviewed expressed concern at some of the existing developments approved in the study area. The proposed Gateway Park office development and University of Cape Town's Courtyard Development were raised by several I&APs as a major concern.

h. There was general agreement that only certain parts of the study area would be suitable for housing or the creation of employment.

4.3 USING THE ENVIRONMENTAL ELEMENTS TO ANALYSE THE STUDY AREA

Based on the review above, the following environmental elements were identified to be utilised in assessing the opportunities and constraints on land-use in the study area:

a. Relief
b. Geophysical Elements
c. Hydrology
d. Pollution
e. Flora
f. Fauna
g. Transportation Infrastructure
h. Wet Services
i. Other Utility Services
j. History and Archaeology
k. Local Demography
l. Land-Use and Land-Ownership
m. Zoning
n. Policies and Plans
o. Issues and Concerns
p. Location

Three environmental elements which were discussed in section 4.2 were omitted from the analysis. These were *climate* and *security* which were found to be similar to the whole of the Cape Town region and therefore proffered no specific opportunity or constraint to land-use planning. *Recreation* was also omitted as it was included in the analysis under the element of *location*.

In the following chapter, the opportunities and constraints proffered by the environmental elements on various land-use options will be investigated. From this investigation, the preferable land-use options for the study area will be determined.

CHAPTER 5
LAND-USE OPTIONS AND FUNCTIONAL UNITS

5.1 AIM OF THIS CHAPTER

Having first divided the study area into separate functional units, it is the aim of this chapter to determine the optimal land-use alternative for each functional unit, taking due regard of all the environmental elements influencing the study area. In undertaking the analysis, it is also aimed to explain a method of analysis which could be used to guide land-use planning for other areas of the city.

5.2 DIVIDING THE STUDY AREA INTO FUNCTIONAL UNITS

The study area, as determined by its preset boundaries, does not form a single homogenous unit. In fact, it shows such a wide range of differing environmental characteristics that the analysis could not be effectively undertaken on the area as a single unit.

It was therefore decided to subdivide the study area into a set of smaller areas termed functional units. Each functional unit was then analysed separately. The opportunities and constraints, in terms of all environmental elements influencing the functional unit, were assessed and the optimal land-use alternative established for each unit.

For the purposes of this study, the study area was firstly subdivided on the basis of land ownership. Each section of the study area owned by a different party was treated as a separate functional unit. However, some areas divided in this manner still displayed a wide range of environmental characteristics. These areas were therefore further subdivided according to different land-uses. The study area was subdivided into fourteen different functional units, and these were:

A. South African Astronomical Observatory
B. Liesbeeck Sports Grounds
C. Maitland Garden Village
D. Alexandra Care and Rehabilitation Centre
E. Maitland Residential/Commercial Area
F. Golf Driving Range

G. Site for Proposed Gateway Park Development
H. Raapenberg Bird Sanctuary
I. University of Cape Town's Homestead Development
J. Valkenberg Homestead
K. Valkenberg Hospital
L. Remainder of Cape Town City Council Owned Property, Western Side of Black River
M. Remainder of Cape Town City Council Owned Property, Eastern Side of Black River
N. Vincent Pallotti Hospital

The Vincent Pallotti Hospital, although it was part of the study area, was not subjected to the analysis outlined in the study. It was deemed that the land-use of this functional unit was entrenched and therefore highly unlikely to be changed.

The locations of these functional units within the study area could be identified by referring to Figures 4.2 and 5.1.

5.3 DETERMINING THE OPTIMAL LAND-USE ALTERNATIVE OF EACH FUNCTIONAL UNIT

5.3.1 Method of Analysis

The study utilised the modified version of the Leopold Matrix method of analysis, explained in Chapter 2, to determine the optimal land-use alternative for each functional unit. The environmental elements characteristic of each functional unit (identified in Chapter 4) were assessed against the different land-use alternatives identified for the study area (identified in Chapter 3). The land-use option for which the environmental elements proffered the most opportunities and fewest constraints was then selected as the preferred option.

5.3.2 The Land-Use Alternatives

The land-use alternatives for which a regional need was established were discussed in Chapter 3. Those land-use options determined to be appropriate for the study area are:

a. Education
b. Employment
c. Housing
d. Public Facilities

e. Transportation
f. Health Facilities
g. Conservation

5.3.3 The Environmental Elements

Those environmental elements identified in Chapter 4 as important factors to be considered by land-use planning for the study area are:

a. Relief
b. Geophysical Elements
c. Hydrology
d. Pollution
e. Flora
f. Fauna
g. Transportation Infrastructure
h. Wet Services
i. Other Utility Services
j. History and Archaeology
k. Local Demography
l. Land-Use and Land-Ownership
m. Zoning
n. Policies and Plans
o. Issues and Concerns
p. Location

5.3.4 The Modified Leopold Matrices of the Functional Units

Table 5.1 to Table 5.13 contain the consolidated modified Leopold Matrices of the functional units. A detailed description of the methodology utilised to obtain these matrices can be found in Chapter 2 of this report.

With each matrix, the order of preference of the different land-use options are listed. A brief description of the major environmental elements is also included with each matrix. This would assist a project proponent to determine which environmental elements proffered major opportunities and which proffered constraints. The raw scoring matrices, from which the consolidated matrices were derived, are attached in Appendix A of this report.

TABLE 5.1: SOUTH AFRICAN ASTRONOMICAL OBSERVATORY

ENVIRONMENTAL ELEMENTS / LAND-USE OPTIONS	RELIEF	GEOPHYSICAL	HYDROLOGY	POLLUTION	FLORA	FAUNA	TRANSPORT	WET SERVICES	OTHER SERVICES	HISTORICAL	DEMOGRAPHY	LAND USE & OWNERS	ZONING	POLICIES & PLANS	SOCIAL ISSUES	LOCATION	OPPORTUNITIES	CONSTRAINTS	SUMMARY	RANKING
EDUCATION	4						4			6		6	6			6	32		32	2
EMPLOYMENT	4	4					4	4	4	-6		-6	-6		-6	-6	20	30	-10	5
HOUSING	4	4					4	4	4	-9		-9	-6		-6	-4	20	34	-16	6
PUBLIC FACILITIES					4	4	4	4		9		6	6		6	4	47		47	1
TRANSPORTATION		4								-9		-9	-6		-6	-4	4	34	-30	7
HEALTH	4						4	4	4			6	6			4	32		32	2
CONSERVATION			-4		-4	4				9		9	6		6	6	40	8	32	2

MAP REF. A
OWNER FOUNDATION FOR RESEARCH DEVELOPMENT
USER SOUTH AFRICAN ASTRONOMICAL OBSERVATORY

RANKING OF LAND-USE OPTIONS:

1. PUBLIC FACILITIES
2. EDUCATION; HEALTH FACILITIES; CONSERVATION
3. -
4. -
5. EMPLOYMENT
6. HOUSING
7. TRANSPORTATION

MAJOR ENVIRONMENTAL ELEMENTS:

1. HISTORY & ARCHITECTURE is important as the buildings of the Observatory were constructed in 1825 and should therefore be considered as significant.
2. LAND-USE & OWNERS create major opportunities and constraints as they have their own plans for the development of this functional unit.
3. ZONING should be considered as important, and the area is zoned for Community Facilities.
4. SOCIAL ISSUES & CONCERNS are important as there was conflict between different I&APs as to what land-use option would be suitable for this functional unit.

TABLE 5.2: LIESBEECK SPORTS GROUNDS

ENVIRONMENTAL ELEMENTS / LAND-USE OPTIONS	RELIEF	GEOPHYSICAL	HYDROLOGY	POLLUTION	FLORA	FAUNA	TRANSPORT	WET SERVICES	OTHER SERVICES	HISTORICAL	DEMOGRAPHY	LANDUSE&OWNERS	ZONING	POLICIES&PLANS	SOCIAL ISSUES	LOCATION	OPPORTUNITIES	CONSTRAINTS	SUMMARY	RANKING
EDUCATION	4	-4	-4				4					-6	6			6	20	14	6	3
EMPLOYMENT	4	-6	-9			-4	4	4	4			6	-6		-6		22	31	-9	5
HOUSING	4	-6	-9	-4		-4	4	4	4			6	-6		-6		22	35	-13	7
PUBLIC FACILITIES		-4	-6	-4		6	4	4				-6	6		6	6	32	20	12	1
TRANSPORTATION		-6	-9				4					6	-6		-6	6	16	27	-11	6
HEALTH	4	-4	-9				4	4	4			-6				6	20	19	1	4
CONSERVATION		-4	9	-4	-6	4						-9	6	6		9	34	23	11	2

MAP REF. B
OWNER TRANSNET/SARCC
USER LIESBEECK SPORTS GROUNDS

RANKING OF LAND-USE OPTIONS:

1. PUBLIC FACILITIES
2. CONSERVATION
3. EDUCATION
4. HEALTH FACILITIES
5. EMPLOYMENT
6. TRANSPORTATION
7. HOUSING

MAJOR ENVIRONMENTAL ELEMENTS:

1. GEOMORPHOLOGY, GEOLOGY, SOILS as a large portion of the functional unit is located in an old wetland area that was filled in with unknown material which include rubble.
2. HYDROLOGY as a large section of the functional unit is subjected to regular flooding during winter.
3. LAND-USE & OWNERS present major opportunities and constraints, as Transnet is by law defined as a private company and they want to profit from the use of this functional unit.
4. ZONING is a legally binding form of development control, and the area is zoned for Community Facilities use.
5. SOCIAL ISSUES & CONCERNS create several opportunities and constraints as many of the I&AP's interviewed believed that the functional unit should not be used for profit, but that it should remain publicly owned and used for the benefit of the broader community.
6. LOCATION is important as the functional unit is an undeveloped area located close to the CBD of Cape Town.

TABLE 5.3: MAITLAND GARDEN VILLAGE

ENVIRONMENTAL ELEMENTS / LAND-USE OPTIONS	RELIEF	GEOPHYSICAL	HYDROLOGY	POLLUTION	FLORA	FAUNA	TRANSPORT	WET SERVICES	OTHER SERVICES	HISTORICAL	DEMOGRAPHY	LANDUSE&OWNERS	ZONING	POLICIES&PLANS	SOCIAL ISSUES	LOCATION	OPPORTUNITIES	CONSTRAINTS	SUMMARY	RANKING
EDUCATION	4	4					6	6			6	6			4	6	42		42	5
EMPLOYMENT	4	6					6	6	9		9	6		9	4	9	68		68	2
HOUSING	4	6					6	6	9		9	9	9	9	4	9	80		80	1
PUBLIC FACILITIES	4	4					6	4			6	9	6	6	4	6	55		55	3
TRANSPORTATION	4	6					4				9	4			4	4	35		35	6
HEALTH	4	4					6	6	4		4	6			4	4	42		42	4
CONSERVATION					-4	-4				4	-6	-4				-6	4	24	-20	7

MAP REF. C
OWNER PRIVATE/CCC
USER MAITLAND GARDEN VILLAGE

RANKING OF LAND-USE OPTIONS:

1. HOUSING
2. EMPLOYMENT
3. PUBLIC FACILITIES
4. HEALTH FACILITIES
5. EDUCATION
6. TRANSPORTATION
7. CONSERVATION

MAJOR ENVIRONMENTAL ELEMENTS:

1. The TRANSPORT INFRASTRUCTURE is well developed for both road and rail transport in the vicinity of the functional unit.
2. The WET SERVICES are well developed around this functional unit.
3. LOCAL DEMOGRAPHY is an important factor as the functional unit is largely a residential development and the residents are generally poor.
4. LAND-USE & OWNERS create opportunities for development as both groups feels that development and upgrading is needed in this functional unit.
5. The LOCATION of the functional unit creates several opportunities for development in the functional unit, as this is an existing residential area, close to employment opportunities and in need of upgrading.

TABLE 5.4: ALEXANDRA CARE AND REHABILITATION CENTRE

ENVIRONMENTAL ELEMENTS / LAND-USE OPTIONS	RELIEF	GEOPHYSICAL	HYDROLOGY	POLLUTION	FLORA	FAUNA	TRANSPORT	WET SERVICES	OTHER SERVICES	HISTORICAL	DEMOGRAPHY	LANDUSE&OWNERS	ZONING	POLICIES&PLANS	SOCIAL ISSUES	LOCATION	OPPORTUNITIES	CONSTRAINTS	SUMMARY	RANKING
EDUCATION	4			-4			4	4	4			4	6		?	6	32	4	28	2
EMPLOYMENT	4	4					6	6	6			-4			?	4	30	4	26	4
HOUSING	4	6		-4			6	6	6			-9			?	4	32	13	19	5
PUBLIC FACILITIES		4		-4			6	4		6		6	6		?		32	4	28	2
TRANSPORTATION		6					6					-9	6		?		18	9	9	7
HEALTH		4		-4			6	6	6			9	6		?	9	46	4	42	1
CONSERVATION				-4						6		4	6		?		16	4	12	6

MAP REF. D

OWNER DEPARTMENT OF COMMUNITY HEALTH AND WELFARE

USER ALEXANDRA CARE AND REHABILITATION CENTRE

RANKING OF LAND-USE OPTIONS:

1. HEALTH FACILITIES
2. EDUCATION; PUBLIC FACILITIES
3. -
4. EMPLOYMENT
5. HOUSING
6. CONSERVATION
7. TRANSPORTATION

MAJOR ENVIRONMENTAL ELEMENTS:

1. TRANSPORT INFRASTRUCTURE is well developed around this functional unit which makes it accessible.
2. LAND-USE & OWNERS creates many opportunities and constraints for various forms of land-use options as the present users are keen to amalgamate with Valkenberg to form a major mental health centre.
3. ZONING is an important legal development control and the area is zoned for Community Facilities use.
4. SOCIAL ISSUES & CONCERNS is an important factor as the I&AP's interviewed were divided which land-use option would be preferable for the functional unit.

TABLE 5.5: MAITLAND RESIDENTIAL/COMMERCIAL AREA

ENVIRONMENTAL ELEMENTS / LAND-USE OPTIONS	RELIEF	GEOPHYSICAL	HYDROLOGY	POLLUTION	FLORA	FAUNA	TRANSPORT	WET SERVICES	OTHER SERVICES	HISTORICAL	DEMOGRAPHY	LANDUSE&OWNERS	ZONING	POLICIES&PLANS	SOCIAL ISSUES	LOCATION	OPPORTUNITIES	CONSTRAINTS	SUMMARY	RANKING
EDUCATION	4	4		-4			6	4	4		4	6			6	4	42	4	38	4
EMPLOYMENT	4	4					6	9	9		6	9	9		6	6	68		68	2
HOUSING	4	6		-4			6	9	9		6	9	9		6	9	73	4	69	1
PUBLIC FACILITIES		4		-4			6				4						14	4	10	6
TRANSPORTATION		6					6				4	-6				4	20	6	14	5
HEALTH	4	4		-4			6	6	6		4	6			6	4	46	4	42	3
CONSERVATION				-4	-4	-4	-4			-4	-4							24	-24	7

MAP REF. E

OWNER PRIVATE/TRANSNET

USER MAITLAND RESIDENTIAL/COMMERCIAL AREA

RANKING OF LAND-USE OPTIONS:

1. HOUSING
2. EMPLOYMENT
3. HEALTH FACILITIES
4. EDUCATION
5. TRANSPORTATION
6. PUBLIC FACILITIES
7. CONSERVATION

MAJOR ENVIRONMENTAL ELEMENTS:

1. The well developed road and rail TRANSPORT INFRASTRUCTURE in the area is a major influencing factor on the functional unit.
2. Major development opportunities are created by the PRESENT LAND-OWNERS & USERS, as the functional unit is presently used for residential and industrial purposes.
3. SOCIAL ISSUES & CONCERNS are important as many I&APs interviewed agreed that the functional unit should be upgraded.

TABLE 5.6: GOLF DRIVING RANGE

ENVIRONMENTAL ELEMENTS / LAND-USE OPTIONS	RELIEF	GEOPHYSICAL	HYDROLOGY	POLLUTION	FLORA	FAUNA	TRANSPORT	WET SERVICES	OTHER SERVICES	HISTORICAL	DEMOGRAPHY	LANDUSE&OWNERS	ZONING	POLICIES&PLANS	SOCIAL ISSUES	LOCATION	OPPORTUNITIES	CONSTRAINTS	SUMMARY	RANKING
EDUCATION		4		-4			4				4	9			6	4	27	4	23	5
EMPLOYMENT		4	-6				6	6	6		6	9	-6		4	4	45	10	35	2
HOUSING		4	-6	-4			6	6	6		6	9	9		6	6	58	10	48	1
PUBLIC FACILITIES		4		-4	4		6				4	9			6	6	35	4	31	4
TRANSPORTATION	-4	4	-4				4				4		-6		4	4	29	14	15	6
HEALTH		4		-4			6	6	4		4	9			6		39	4	35	2
CONSERVATION			4	-4	-4						-4	4			-4		8	16	-8	7

MAP REF. F
OWNER CAPE TOWN CITY COUNCIL
USER GOLF DRIVING RANGE

RANKING OF LAND-USE OPTIONS:

1. HOUSING
2. EMPLOYMENT; HEALTH FACILITIES
3. -
4. PUBLIC FACILITIES
5. EDUCATION
6. TRANSPORTATION
7. CONSERVATION

MAJOR ENVIRONMENTAL ELEMENTS:

1. The TRANSPORT INFRASTRUCTURE around the functional unit is well developed, making the area accessible.
2. Present LAND-USERS & OWNERS is the City Council, who would present few constraints to the area being used for residential purposes.
3. SOCIAL ISSUES & CONCERNS is an important element, as several I&APs interviewed believed this functional unit should be used in a more productive manner.

TABLE 5.7: SITE FOR PROPOSED GATEWAY PARK DEVELOPMENT

ENVIRONMENTAL ELEMENTS / LAND-USE OPTIONS	RELIEF	GEOPHYSICAL	HYDROLOGY	POLLUTION	FLORA	FAUNA	TRANSPORT	WET SERVICES	OTHER SERVICES	HISTORICAL	DEMOGRAPHY	LANDUSE&OWNERS	ZONING	POLICIES&PLANS	SOCIAL ISSUES	LOCATION	OPPORTUNITIES	CONSTRAINTS	SUMMARY	RANKING
EDUCATION		4					4	4	4		4	-4	4	-6	?	4	28	10	18	4
EMPLOYMENT	4	4					6	6	6		6	6	6	6	?	-4	48	4	44	1
HOUSING	4	4					6	6	6		4	4	4	-6	?	-4	38	10	28	3
PUBLIC FACILITIES		4					6	6			4	-4		-6	?	4	22	10	12	5
TRANSPORTATION		4					4	4						-6	?	-4	12	10	2	6
HEALTH		4					6	6	6		4	6		-6	?	4	36	6	30	2
CONSERVATION					-4		-4				-4	-4	-4	-6	?	-4		34	-34	7

MAP REF. G

OWNER MEDICAL RESEARCH COUNCIL

USER SITE FOR PROPOSED GATEWAY PARK DEVELOPMENT

RANKING OF LAND-USE OPTIONS:

1. EMPLOYMENT
2. HEALTH FACILITIES
3. HOUSING
4. EDUCATION
5. PUBLIC FACILITIES
6. TRANSPORTATION
7. CONSERVATION

MAJOR ENVIRONMENTAL ELEMENTS:

1. The TRANSPORT INFRASTRUCTURE, as well as the WET SERVICES and UTILITY SERVICES are well developed around the functional unit.
2. POLICIES & PLANS will have a strong influence on land-use options for the unit, as plans for an office and warehouse type of development has been approved by the Cuty Council.
3. SOCIAL ISSUES & CONCERNS is an important component, as the I&APs interviewed were divided which type of land-use would be appropriate for the functional unit.

TABLE 5.8: RAAPENBERG BIRD SANCTUARY

ENVIRONMENTAL ELEMENTS / LAND-USE OPTIONS	RELIEF	GEOPHYSICAL	HYDROLOGY	POLLUTION	FLORA	FAUNA	TRANSPORT	WET SERVICES	OTHER SERVICES	HISTORICAL	DEMOGRAPHY	LANDUSE&OWNERS	ZONING	POLICIES&PLANS	SOCIAL ISSUES	LOCATION	OPPORTUNITIES	CONSTRAINTS	SUMMARY	RANKING
EDUCATION		-4	-4	-4	4	4	4	4	4		4	4	4	4	4	4	44	12	32	3
EMPLOYMENT		-4	-9		-6	-6	4	4	4			4			-6	4	20	29	-9	5
HOUSING		-6	-9	-6	-6	-6	4	4	4			4			-6	4	20	39	-10	6
PUBLIC FACILITIES		-4	-4	-4	4	4	4	4	4		4	4	6	4	4	4	46	12	34	2
TRANSPORTATION		-6	-6		-4	-4	4					-4		-4	-6	4	8	34	-26	7
HEALTH		-6	-9	-6			4	4	4				6		4	4	26	21	5	4
CONSERVATION			6	-4	9	9	-4				-4	6	4	6	6	6	52	12	40	1

MAP REF. H

OWNER CAPE TOWN CITY COUNCIL

USER RAAPENBERG BIRD SANCTUARY

RANKING OF LAND-USE OPTIONS:

1. CONSERVATION
2. PUBLIC FACILITIES
3. EDUCATION
4. HEALTH FACILITIES
5. EMPLOYMENT
6. HOUSING
7. TRANSPORTATION

MAJOR ENVIRONMENTAL ELEMENTS

1. The area is subjected to regular flooding, thus is HYDROLOGY an important environmental element to consider.
2. SOCIAL ISSUES & CONCERNS are important as I&APs interviewed in general agreed the area is a site worthy of conserving.

TABLE 5.9: SITE FOR HOMESTEAD DEVELOPMENT

ENVIRONMENTAL ELEMENTS / LAND-USE OPTIONS	RELIEF	GEOPHYSICAL	HYDROLOGY	POLLUTION	FLORA	FAUNA	TRANSPORT	WET SERVICES	OTHER SERVICES	HISTORICAL	DEMOGRAPHY	LANDUSE&OWNERS	ZONING	POLICIES&PLANS	SOCIAL ISSUES	LOCATION	OPPORTUNITIES	CONSTRAINTS	SUMMARY	RANKING
EDUCATION		4		-4			4	4	4	4		6	6	4	?	4	40	4	36	2
EMPLOYMENT	4	4				-4	6	6	6	-4		4		-4	?	4	34	12	22	4
HOUSING	4	4		-4		-4	6	6	6	-4		-4		-4	?	4	30	20	10	5
PUBLIC FACILITIES				-4		4	6	4	4	6		4	6	4	?	4	42	4	38	1
TRANSPORTATION		4				-4				-4		-4	-4	-4	?	-4	4	24	-20	7
HEALTH	4	4		-4			4	4	4			4	4		?	4	32	4	28	3
CONSERVATION				-4	-4	4				6		4		4	?	4	18	8	10	5

MAP REF. I
OWNER UNIVERSITY OF CAPE TOWN
USER HOMESTEAD DEVELOPMENT

RANKING OF LAND-USE OPTIONS:

1. PUBLIC FACILITIES
2. EDUCATION
3. HEALTH FACILITIES
4. EMPLOYMENT
5. HOUSING; CONSERVATION
6.
7. TRANSPORTATION

MAJOR ENVIRONMENTAL ELEMENTS:

1. SOCIAL ISSUES & CONCERNS is one of the most important elements to consider, as the I&APs interviewed strongly disagreed on the appropriateness of UCT's proposed development in the functional unit.

TABLE 5.10: VALKENBERG HOMESTEAD

ENVIRONMENTAL ELEMENTS / LAND-USE OPTIONS	RELIEF	GEOPHYSICAL	HYDROLOGY	POLLUTION	FLORA	FAUNA	TRANSPORT	WET SERVICES	OTHER SERVICES	HISTORICAL	DEMOGRAPHY	LANDUSE&OWNERS	ZONING	POLICIES&PLANS	SOCIAL ISSUES	LOCATION	OPPORTUNITIES	CONSTRAINTS	SUMMARY	RANKING
EDUCATION		4		-4			4	4	4	4		4		4	4	4	36	4	32	2
EMPLOYMENT	4	4					6	6	6	-9		-4	6	-6	4	4	40	19	21	5
HOUSING	4	4		-4			6	6	6	-6		-4		-6	-4	4	30	24	6	6
PUBLIC FACILITIES				-4			6	6	6	6		6		6	6	4	46	4	42	1
TRANSPORTATION		4								-6		-4		-9	-4	-4	4	24	-20	7
HEALTH	4	4		-4			4	4	4	4		-4		4	4	4	36	8	28	3
CONSERVATION				-4						9		6	-4	9	6	4	31	8	23	4

MAP REF. J
OWNER NATIONAL MONUMENTS COUNCIL
USER VALKENBERG HOMESTEAD

RANKING OF LAND-USE OPTIONS:

1. PUBLIC FACILITIES
2. EDUCATION
3. HEALTH FACILITIES
4. CONSERVATION
5. EMPLOYMENT
6. HOUSING
7. TRANSPORTATION

MAJOR ENVIRONMENTAL ELEMENTS:

1. The HISTORICAL component is important, as the homestead is of significant historical value.
2. The Homestead is part of the approved development plans for the UCT Homestead development, therefore is POLICIES & PLANS an important element.

TABLE 5.11: VALKENBERG HOSPITAL

ENVIRONMENTAL ELEMENTS / LAND-USE OPTIONS	RELIEF	GEOPHYSICAL	HYDROLOGY	POLLUTION	FLORA	FAUNA	TRANSPORT	WET SERVICES	OTHER SERVICES	HISTORICAL	DEMOGRAPHY	LANDUSE&OWNERS	ZONING	POLICIES&PLANS	SOCIAL ISSUES	LOCATION	OPPORTUNITIES	CONSTRAINTS	SUMMARY	RANKING
EDUCATION		4		-4		4	6	4	4	4	4	6	4		4	4	48	4	44	2
EMPLOYMENT	4	6				-4	6	4	4		4	6	-4		4	4	40	8	32	4
HOUSING	4	6		-4		-4	6	4	4		4	-6	-4			4	32	16	16	5
PUBLIC FACILITIES		4		-4	4	4	6	4		6	4	6	4		4	4	48	4	44	2
TRANSPORTATION	4	6								-4	4	-6			-4	4	18	14	4	7
HEALTH	4	4		-4			6	4	4		4	9	4		4	6	53	4	49	1
CONSERVATION				-4	-4	4				6	4	4				4	22	8	14	6

MAP REF. K

OWNER DEPARTMENT OF COMMUNITY DEVELOPMENT

USER VALKENBERG HOSPITAL

RANKING OF LAND-USE OPTIONS:

1. HEALTH FACILITIES
2. EDUCATION; PUBLIC FACILITIES
3.
4. EMPLOYMENT
5. HOUSING
6. CONSERVATION
7. TRANSPORTATION

MAJOR ENVIRONMENTAL ELEMENTS:

1. Existing infrastructure, in particular TRANSPORTATION INFRASTRUCTURE, around the functional area is well developed, making the area very accessible to the public.
2. Existing LAND-USERS & OWNERS is an important element to consider by land-use planners.

TABLE 5.12: CCC PROPERTY WEST OF BLACK RIVER

ENVIRONMENTAL ELEMENTS / LAND-USE OPTIONS	RELIEF	GEOPHYSICAL	HYDROLOGY	POLLUTION	FLORA	FAUNA	TRANSPORT	WET SERVICES	OTHER SERVICES	HISTORICAL	DEMOGRAPHY	LANDUSE&OWNERS	ZONING	POLICIES&PLANS	SOCIAL ISSUES	LOCATION	OPPORTUNITIES	CONSTRAINTS	SUMMARY	RANKING
EDUCATION			-9	-4			6	4	4		4	4	6		4	4	36	13	23	3
EMPLOYMENT	4		-9				6	4	4		4	4				4	30	9	21	5
HOUSING	4	-4	-9	-4			6	4	4			4				4	26	17	9	6
PUBLIC FACILITIES				-4	4	4	6				-4	4	6	6	4	4	38	8	30	1
TRANSPORTATION	4	-4	-6		-4	-4	4				4	4		4		4	24	18	6	7
HEALTH			-9	-4	4		6	4	4		4	4	6			4	36	13	23	3
CONSERVATION			6	-4	4	4				4	-4		4		4	4	30	8	22	2

MAP REF. L

OWNER CAPE TOWN CITY COUNCIL

USER REMAINDER OF CCC PROPERTY, WEST OF BLACK RIVER

RANKING OF LAND-USE OPTIONS:

1. PUBLIC FACILITIES
2. CONSERVATION
3. EDUCATION; HEALTH FACILITIES
4. -
5. EMPLOYMENT
6. HOUSING
7. TRANSPORTATION

MAJOR ENVIRONMENTAL ELEMENTS:

1. HYDROLOGY is an important element as large sections of the functional unit are subjected to flooding during winter.
2. TRANSPORTATION INFRASTRUCTURE is well developed, making the unit accessible to the public.

5.3.5 Mapping the Preferred Land-Use Alternatives

A visual representation of the preferred land-use alternatives for the functional units, in the form of a map of the study area is presented. The preferred land-use alternatives, as determined in section 5.3.4 are indicated on this map. Figure 5.1 represents the preferred land-use alternatives for each functional unit.

5.3.6 Mapping the Optimal Land-Use Alternative

A visual analysis of Figure 5.1 was undertaken, and any land-use options considered to be inappropriate, seen in context of the study area, were then changed. A map indicating the optimal land-use option for each functional unit was then produced. Figure 5.2 represents the optimal land-use alternatives for the functional units of the study area.

The functional units of which the preferred land-use options were changed are:

a. Maitland Residential/Commercial Area (E) was changed from **Housing** to a combination of **Housing and Employment**. The reason is that a part of this functional unit is presently utilised for commercial purposes.

b. The site for the proposed Gateway Park development (G) was changed from **Employment** to **Health Facilities**, as the functional unit is located between Vincent Pallotti and Valkenberg Hospitals.

c. The remainder of CCC property, West of Black River (L) was changed from **Public Facilities** to **Conservation**. The reason was that the area is located alongside the Black River and therefore subjected to regular flooding. This area also forms a natural extension of Raapenberg Bird Sanctuary.

d. The remainder of CCC property, East of Black River (M) was changed from **Education** to a combination of **Education and Conservation**. The reason was that the Pallotti wetlands are located in this functional unit which were considered to be worthy of conservation.

TABLE 5.13: CCC OWNED LAND EAST OF BLACK RIVER

ENVIRONMENTAL ELEMENTS / LAND-USE OPTIONS	RELIEF	GEOPHYSICAL	HYDROLOGY	POLLUTION	FLORA	FAUNA	TRANSPORT	WET SERVICES	OTHER SERVICES	HISTORICAL	DEMOGRAPHY	LANDUSE&OWNERS	ZONING	POLICIES&PLANS	SOCIAL ISSUES	LOCATION	OPPORTUNITIES	CONSTRAINTS	SUMMARY	RANKING
EDUCATION			-4			4	4	4	4		4	4			?	4	28	4	24	1
EMPLOYMENT			-6			-4	4	4	4		4	4	6		?	4	30	10	20	2
HOUSING			-6	-4		-4	4	4	4		4	4	-4		?	4	24	18	6	6
PUBLIC FACILITIES		4	-4	-4	4	4	4					4	4		?		24	8	18	4
TRANSPORTATION			-9			-4	4				4		-4		?		8	13	-5	7
HEALTH	4		-4	-4			4	4	4		4	4	4		?		28	8	20	2
CONSERVATION			6	-4	6	6						4	-4		?	4	26	8	18	4

MAP REF. M

OWNER CAPE TOWN CITY COUNCIL

USER REMAINDER OF CCC PROPERTY, EAST OF BLACK RIVER

RANKING OF LAND-USE OPTIONS:

1. EDUCATION
2. EMPLOYMENT; HEALTH FACILITIES
3. -
4. PUBLIC FACILITIES; CONSERVATION
5. -
6. HOUSING
7. TRANSPORTATION

MAJOR ENVIRONMENTAL ELEMENTS:

1. HYDROLOGY will influence land-use options significantly, as parts of the functional unit are subjected to regular flooding.
2. The I&APs interviewed were divided on which land-use alternative is preferable for the functional unit, so SOCIAL ISSUES & CONCERNS is an important element.

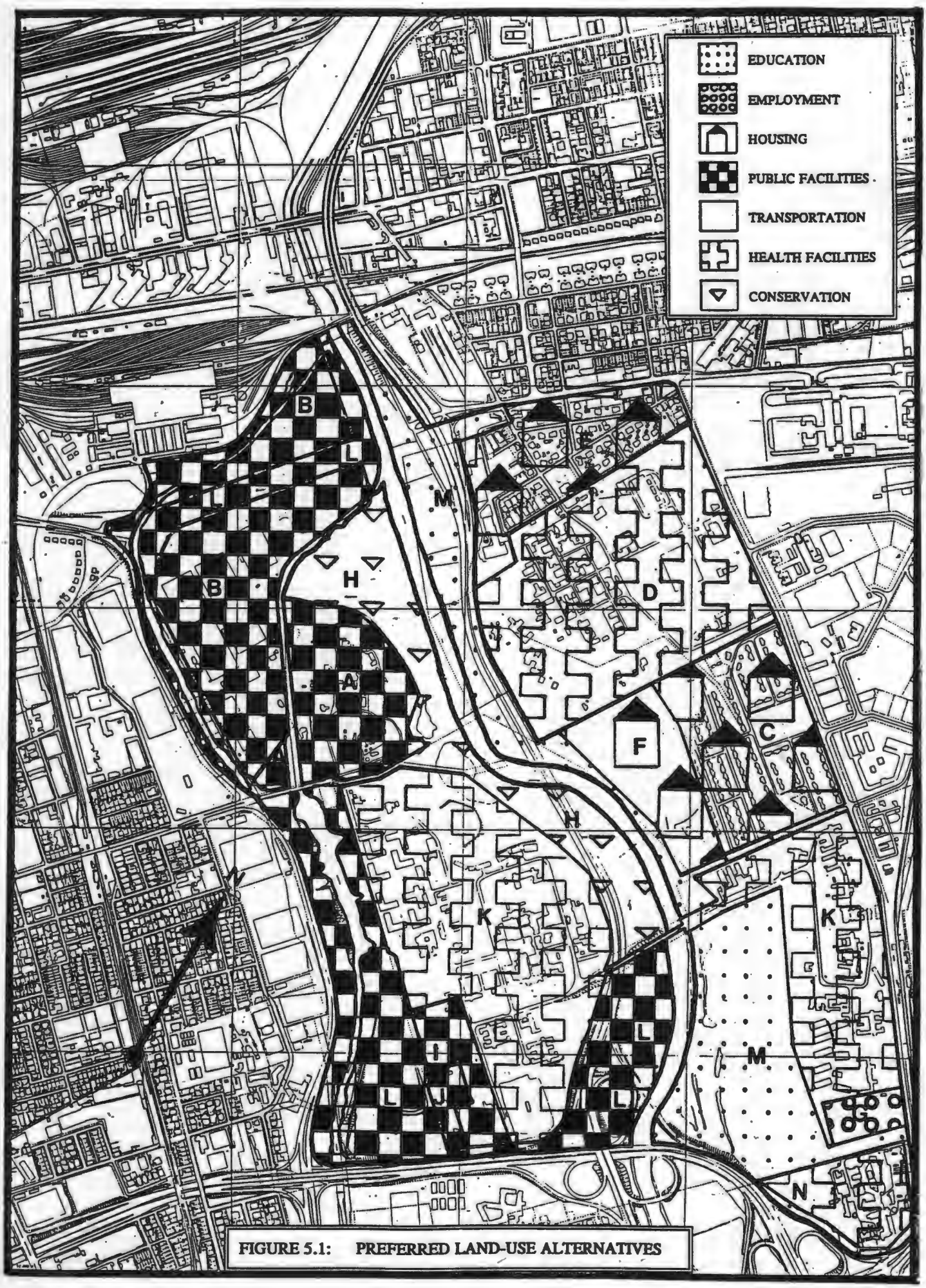

FIGURE 5.1: PREFERRED LAND-USE ALTERNATIVES

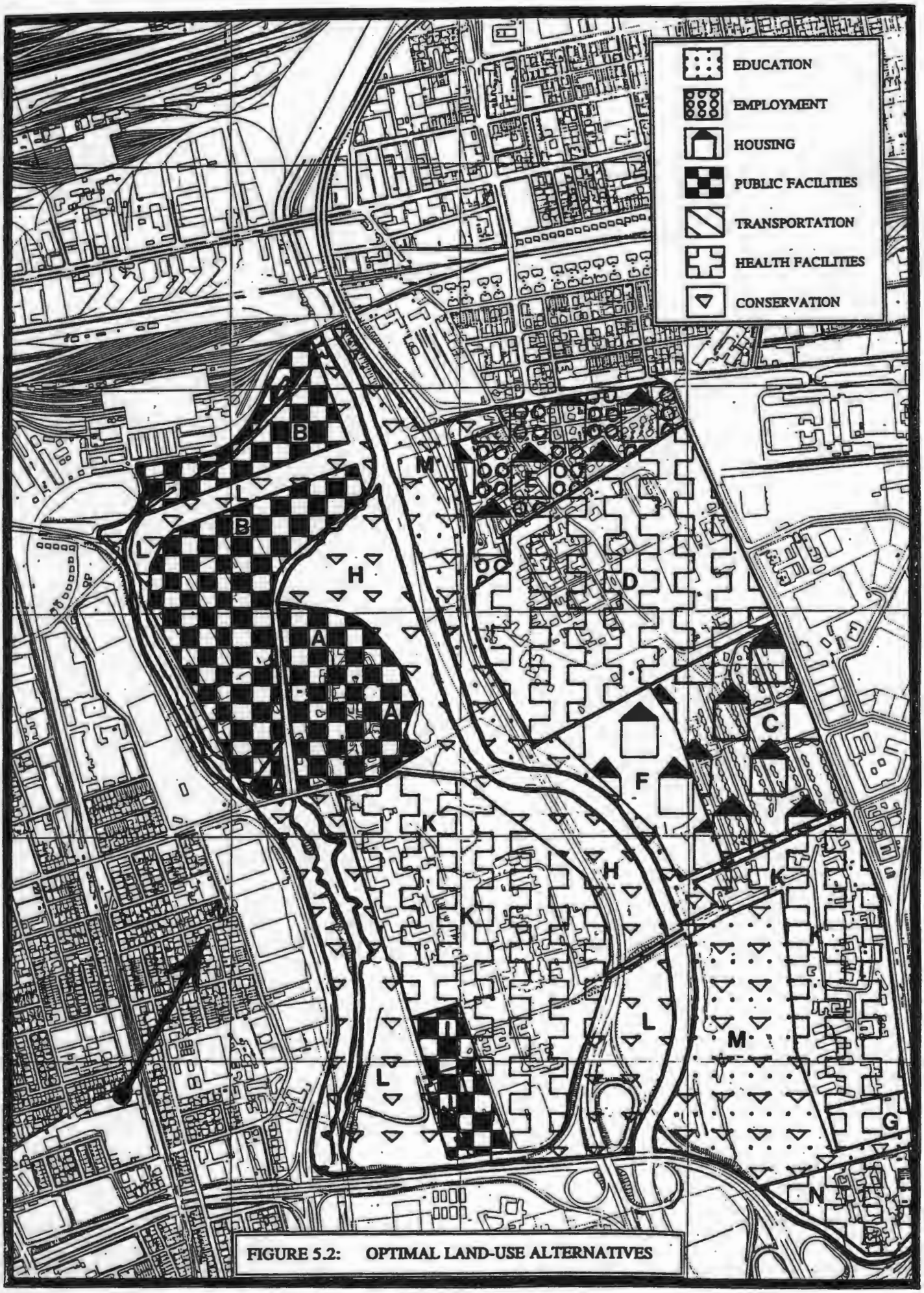

FIGURE 5.2: OPTIMAL LAND-USE ALTERNATIVES

CHAPTER 6
SUMMARY AND CONCLUSIONS

6.1 INTRODUCTION

In assessing the opportunities and constraints for various land-use options at the Liesbeeck-Black River confluence area, it is important to recognise that:

* Cape Town has the potential to "become one of the world's most livable cities" [De Tolly, 1993:18]. This is ensured by the beauty of its natural setting, the mountain, the sea, its people and the unique architecture of the city.

* There is intense pressure on the city of Cape Town for development to address the needs of its residents. This pressure is ever increasing as the urban population is growing daily.

* Due to the continued growth of the city, the remaining open space becomes increasingly more valuable. The value of this land can be expressed on two levels. In the first place it is important in providing space for further development, and secondly it is valuable for maintaining recreational open space system within the city.

* If Cape Town is to realise its full potential as one of the world's "great" cities, it must address the needs of all its residents. This is especially important for the urban poor who, until now, have been neglected by city planning.

* Due to its location in relation to the CBD of Cape Town, as well as the relative low density of existing development, the Liesbeeck-Black River confluence area should be considered as a strategic area of land in Cape Town. Land-use planning for this are should therefore endeavour to make maximum use of the opportunities proffered by the area.

This study set out to achieve two principle aims. Firstly to establish a procedure to determine optimal land-use alternatives for an undeveloped area of land in a city. Secondly, it aimed to analyse the Liesbeeck-Black River confluence area and determine optimal land-use

alternatives for this area. The remainder of this chapter will explain the conclusions that can be drawn with respect to these aims.

6.2 ESTABLISHING A PROCEDURE FOR DETERMINING OPTIMAL LAND-USE ALTERNATIVES

The researcher adapted the Leopold Matrix method of analysis to suit the study, and used it to analyse the study area.

6.2.1 The Method of Analysis

a. The matrix can be used to analyse land-use opportunities by rating the effect of the environmental elements characteristic of the study area (listed along the horizontal axis) against possible land-use alternatives (listed along the vertical axis).

b. The cell entries of the matrix are used to express the effect of an environmental element on a particular land-use option as either an opportunity or a constraint. The magnitude and significance of each element's effect can be determined on a rating scale selected by the researcher.

c. The overall effect of the opportunity/constraint proffered by an environmental element can be established by multiplying the significance and magnitude ratings.

d. By adding the overall ratings for each separate land-use option, the preferred land-use alternative for the area can be determined.

e. If it was necessary to subdivide the area into functional units, the preferred land-use alternative for each functional unit can be represented on a map of the whole study area. This allows the researcher to undertake a visual comparison of land-use options between different functional units. It is then possible to alter any land-use alternative deemed to be inappropriate by the researcher.

f. Finally, a map of the study area, indicating the optimal land-use alternatives for each functional unit, can be constructed.

6.2.2 Advantages and Disadvantages of the Method of Analysis

Through the course of the study it became apparent that there are many advantages, as well as disadvantages, related to this method of analysis. The main advantages and disadvantages were found to be:

6.2.2.1 Advantages

a. The matrix provides an analytical method to determine the most preferable land-use option in an area.

b. The environmental information is communicated effectively to the user.

c. The method is simple to use and allow easy comparison between different land-use options in a functional unit.

d. The matrix can easily be adapted to include additional land-use options, or even specific project proposals.

e. The input from I&APs can be incorporated in the process of analysis.

6.2.2.2 Disadvantages

a. Ideally, the rating process should be undertaken by a multi-functional team to avoid individual bias being introduced into the study. In the case of this study, rating was undertaken by one researcher only.

b. Comparison between different functional units was difficult as each functional unit was analysed on a separate matrix.

c. This method of analysis does not take mitigatory measures into account, nor does it consider alternative sites for different land-use options.

d. Bias could be introduced into the study by double counting of some environmental effects.

e. The process of completing a matrix for each functional unit is long process. It involves several people and could therefore be expensive.

f. The matrix does not explain why different ratings were assigned to some land-use options. The reader need to refer to the main report to determine whether the ratings attributed to different options are acceptable.

6.3 ANALYSIS OF THE STUDY AREA

The Modified Leopold Matrix method of Analysis was used to determine the optimal land-use alternatives for the functional units in the study area. From the results of the analysis, it is possible to draw the following conclusions:

6.3.1 Regional Development Considerations

A study of existing research literature indicated several regional development needs and problems in Cape Town. From these needs, the study determined that seven possible land-use options may be appropriate for the study area These options were analysed in terms of their suitability for the study area. The land-use options analysed were:

* Education
* Employment
* Housing
* Public Facilities
* Transportation
* Health Facilities
* Conservation

6.3.2 Environmental Elements Characteristic of the Study Area

The Baseline Study established which environmental elements characterise the study area. Using the summary assessment in the Baseline Report, and the personal judgement of the researcher, the following elements were used to analyse the study area:

* Relief
* Geophysical Elements
* Hydrology
* Pollution
* Flora
* Fauna
* Transportation Infrastructure
* Wet Services
* Other Utility Services
* Historical Elements

* Local Demography
* Land-Users and Owners
* Zoning
* Policies and Plans
* Social Issues and Concerns
* Location

6.3.3 Dividing the Study Area into Functional Units

The study area displayed a wide range of differing environmental characteristics. The area was therefore subdivided into smaller functional units, which displayed more uniform environmental characteristics. It was found that by dividing the study area in units that were owned and used by different parties an efficient subdivision of the area was obtained. This divided the study area into fourteen separate functional units, which were analysed separately. The different units are indicated in section 6.3.4.

6.3.4 Determining Optimal Land-Use Alternatives

Using the Modified Leopold Matrix method of analysis, it was possible to determine the effect of the various environmental elements on the different land-use options. This allowed the researcher to determine the preferred land-use alternative for each functional unit.

The preferred land-use alternatives of the different functional units were represented on a map of the study area (Figure 5.1). This allowed the researcher to undertake a visual analysis of the land-use options in context of the study area, and any option deemed inappropriate was changed. A map of the study area indicating the optimal land-use options for the functional units in the study area was constructed (Figure 5.2).

The optimal land-use alternatives for the functional units were found by the study to be :

* South African Astronomical Observatory - Public Facilities
* Liesbeeck Sports Grounds - Public Facilities
* Maitland Garden Village - Housing
* Alexandra Care and Rehabilitation Centre - Health Facilities
* Maitland Residential/Commercial Area - Housing and Employment
* Golf Driving Range - Housing
* Site for Proposed Gateway Park Development - Health Facilities

* Raapenberg Bird Sanctuary - Conservation
* Site for University of Cape Town's Homestead Development - Public Facilities
* Valkenberg Homestead - Public Facilities
* Valkenberg Hospital - Health Facilities
* Remainder of Cape Town City Council Owned Property, Western Side of Black River - Conservation
* Remainder of Cape Town City Council Owned Property, Eastern Side of Black River - Education and Conservation
* Vincent Pallotti Hospital - Health Facilities

It should be noted that the analysis was undertaken by a single researcher. The analysis could therefore have been influenced by the personal bias of the researcher. It will be possible to overcome this problem by appointing a multi-disciplinary team to undertake the analysis.

CHAPTER 7
RECOMMENDATIONS

7.1 INTRODUCTION

This chapter makes recommendations as to how the results of this study should be used to guide land-use planning for the study area, and for other similar areas in Cape Town.

7.2 USING THE MODIFIED LEOPOLD MATRIX METHOD OF ANALYSIS

The first aim of the study was to establish a procedure whereby optimal land-use alternatives for an area could be determined. The modified Leopold Matrix method of analysis was found to be a useful procedure to achieve this aim. It is recommended that planners wishing to use this method of analysis should attempt to follow the following procedure:

a. Form a multi-disciplinary team (the study team) to analyse the study area. Important disciplines that should be represented on the team are planning, economy, sociology, and natural science (e.g. botany, zoology, geology, geomorphology etc.).

b. Determine the environmental elements characteristic of the study area. The elements should be determined using the knowledge of the study team as well as through interviews with I&APs.

c. Interview a broad range of I&APs to identify their issues and concerns regarding the study area. Additional information on environmental elements could also be gained from these interviews (or public meetings).

d. Research and evaluate the environmental elements.

e. Determine which land-use options could be considered appropriate for the study area.

f. If required, divide the study area into separate homogenous functional units. These functional units could then be treated individually.

g. Use the modified Leopold Matrix method of analysis to determine the effect of an environmental element on a land-use option. This effect should create either an opportunity or constraint on the land-use option. A constraint will be indicated by a negative number.

h. Determine the magnitude and significance of the element's effect on the land-use option. This should be expressed on a scale of 1 to 3, where:

* 1 = low magnitude/significance
* 2 = intermediate magnitude/significance
* 3 = high magnitude/significance

It is important that the process of rating the environmental effects is undertaken by the full study team to avoid personal bias being introduced. Ideally, the ratings should be open for inspection and approval by the I&APs. At the very least should the I&APs be allowed to give their input in the rating process.

i. Determine the combined effect of an environmental element by multiplying the magnitude and significance ratings.

j. Determine the overall effect of all environmental elements by summing them for each land-use option. Due regard should be given to negative numbers.

k. The land-use option displaying the highest positive overall score is considered to be the preferred land-use alternative, as on average the environmental elements proffer the most opportunities and least constraints to that form of land-use.

l. If the study area was subdivided into functional units, the preferred alternatives for each unit should be represented on a map of the study area. This allows for a visual inspection to determine the appropriateness of the land-use options seen in context of the whole study area.

m. Using the results from this form of analysis, the appropriateness of project proposals for an area could then be analysed in the context of the opportunities and constraints proffered by the environment on the area.

7.3 THE LIESBEECK-BLACK RIVER CONFLUENCE AREA

The second aim of the study was to determine the optimal land-use alternatives for the Liesbeeck-Black River confluence area. It is important, however, to realise that the rating process was undertaken by a single researcher. It is therefore strongly recommended that the elements are re-rated by a multi-disciplinary team.

The optimal land-use alternatives for the functional units, as determined by the researcher, are listed in section 6.3.4 while Figure 5.2 gives a graphic representation of the study area, indicating the optimal land-use options.

It is recommended that the optimal land-use alternatives are used to guide development proposals in the study area. It is crucial, however, that any proposed developments in the study area should be subjected to an Environmental Impact Assessment to ensure the proposal takes the opportunities and constraints proffered by the environment into account. This will ensure that the land-use options selected for the study area will be in the best interest of the city of Cape Town and all its residents.

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APPENDIX A
RAW SCORING MATRICES

ENVIRONMENTAL ELEMENTS / LAND-USE OPTIONS	RELIEF	GEOPHYSICAL	HYDROLOGY	POLLUTION	FLORA	FAUNA	TRANSPORT	WET SERVICES	OTHER SERVICES	HISTORICAL	DEMOGRAPHY	LANDUSE&OWNERS	ZONING	POLICIES&PLANS	SOCIAL ISSUES	LOCATION
EDUCATION	2/2		-1/3				2/2			2/3		2/3	3/2	?	1/3	2/3
EMPLOYMENT	2/2	2/2	-1/3				2/2	2/2	2/2	-2/3		-2/3	-3/2	?	-2/3	-2/3
HOUSING	2/2	2/2	-1/3				2/2	2/2	2/2	-3/3		-3/3	-3/2	?	-2/3	-2/2
PUBLIC FACILITIES	1/2	1/2			2/2	2/2	2/2	2/2		3/3		2/3	3/2	?	2/3	2/2
TRANSPORTATION	1/2	2/2	-1/2				2/1			-3/3		-3/3	-3/2	?	-3/2	-2/2
HEALTH	2/2	1/2	-1/3				2/2	2/2	2/2			2/2	3/2	?	1/3	2/2
CONSERVATION			-2/2		-2/2	2/2				3/3		3/3	3/2	?	2/3	2/3

MAP REFERENCE: A
LAND OWNER: FOUNDATION FOR RESEARCH DEVELOPMENT
LAND USER: SOUTH AFRICAN ASTRONOMICAL OBSERVATORY

ENVIRONMENTAL ELEMENTS / LAND-USE OPTIONS	RELIEF	GEOPHYSICAL	HYDROLOGY	POLLUTION	FLORA	FAUNA	TRANSPORT	WET SERVICES	OTHER SERVICES	HISTORICAL	DEMOGRAPHY	LANDUSE&OWNERS	ZONING	POLICIES&PLANS	SOCIAL ISSUES	LOCATION
EDUCATION	2/2	-2/2	-2/2	-2/1			2/2					-2/3	3/2		1/3	2/3
EMPLOYMENT	2/2	-3/2	-3/3	-1/1		-2/2	2/2	2/2	2/2			2/3	-3/2		-2/3	1/3
HOUSING	2/2	-3/2	-3/3	-2/2		-2/2	2/2	2/2	2/2			2/3	-3/2		-2/3	1/3
PUBLIC FACILITIES	1/2	-2/2	-2/3	-2/2		3/2	2/2	2/2				-2/3	3/2		2/3	2/3
TRANSPORTATION	1/2	-3/2	-3/2				2/2					2/3	-3/2		-2/3	2/3
HEALTH	2/2	-2/2	-3/3				2/2	2/2	2/2			-2/3			1/3	2/3
CONSERVATION		-2/2	3/3	-2/2	-2/3	2/2						-3/3	3/2		2/3	3/3

MAP REFERENCE: B
LAND OWNER: TRANSNET
LAND USER: LIESBEECK SPORTSGROUNDS

ENVIRONMENTAL ELEMENTS / LAND-USE OPTIONS	RELIEF	GEOPHYSICAL	HYDROLOGY	POLLUTION	FLORA	FAUNA	TRANSPORT	WET SERVICES	OTHER SERVICES	HISTORICAL	DEMOGRAPHY	LANDUSE&OWNERS	ZONING	POLICIES&PLANS	SOCIAL ISSUES	LOCATION
EDUCATION	2/2	2/2					2/3	2/3			3/2	3/2	-3/1		2/2	3/2
EMPLOYMENT	2/2	2/3					2/3	2/3	3/3		3/3	3/2	-3/1	3/3	2/2	3/3
HOUSING	2/2	2/3					2/3	2/3	3/3		3/3	3/3	3/3	3/3	2/2	3/3
PUBLIC FACILITIES	2/2	2/2			2/1	2/1	2/3	2/2			2/3	3/3	2/3	3/2	2/2	2/3
TRANSPORTATION	2/2	2/3					2/2				3/3	2/2	-3/1		2/2	2/2
HEALTH	2/2	2/2					2/3	2/3	2/2		2/2	2/3	-3/1		2/2	2/2
CONSERVATION					-2/2	-2/2				2/2		-2/2	-3/1			-3/2

MAP REFERENCE: C
LAND OWNER: CAPE TOWN CITY COUNCIL/PRIVATE
LAND USER: MAITLAND GARDEN VILLAGE

ENVIRONMENTAL ELEMENTS / LAND-USE OPTIONS	RELIEF	GEOPHYSICAL	HYDROLOGY	POLLUTION	FLORA	FAUNA	TRANSPORT	WET SERVICES	OTHER SERVICES	HISTORICAL	DEMOGRAPHY	LANDUSE&OWNERS	ZONING	POLICIES&PLANS	SOCIAL ISSUES	LOCATION
EDUCATION	2/2	2/1		-2/2			2/2	2/2	2/2			2/2	2/3		?	2/3
EMPLOYMENT	2/2	2/2		-2/1			2/3	2/3	2/3			-2/2	1/3		?	2/2
HOUSING	2/2	3/2		-2/2			2/3	2/3	2/3			-3/3	-1/3		?	2/2
PUBLIC FACILITIES		2/2		-2/2			2/3	2/2				2/3	3/2		?	1/3
TRANSPORTATION	1/1	2/3					2/3					-2/3	3/2		?	1/3
HEALTH	1/2	2/2		-2/2			3/3	2/3	2/3			3/3	3/2		?	3/3
CONSERVATION				-2/2						3/2		2/2	3/2	3/2	?	

MAP REFERENCE: D
LAND OWNER: DEPARTMENT OF COMMUNITY HEALTH AND WELFARE
LAND USER: ALEXANDRA CARE AND REHABILITATION CENTRE

ENVIRONMENTAL ELEMENTS / LAND-USE OPTIONS	RELIEF	GEOPHYSICAL	HYDROLOGY	POLLUTION	FLORA	FAUNA	TRANSPORT	WET SERVICES	OTHER SERVICES	HISTORICAL	DEMOGRAPHY	LANDUSE&OWNERS	ZONING	POLICIES&PLANS	SOCIAL ISSUES	LOCATION
EDUCATION	2/2	2/2		-2/2			2/3	2/2	2/2		2/2	2/3	-1/1		2/3	2/2
EMPLOYMENT	2/2	2/2		-1/1			2/3	3/3	3/3		2/3	3/3	3/3		2/3	2/3
HOUSING	2/2	2/3		-2/2			2/3	3/3	3/3		3/3	3/3	3/3		2/3	3/3
PUBLIC FACILITIES	2/1	2/2		-2/2			2/3	2/1	2/1		2/2	1/3	-1/1		1/3	1/2
TRANSPORTATION	2/1	2/3					2/3				2/2	-2/3	-1/2		-1/3	2/2
HEALTH	2/2	2/2		-2/2			2/3	2/3	2/3		2/2	2/3	-1/1		2/3	2/2
CONSERVATION				-2/2	-2/2	-2/2	-2/2				-2/2	1/3	-1/1			

MAP REFERENCE: E
LAND OWNER: TRANSNET/PRIVATE
LAND USER: MAITLAND RESIDENTIAL/COMMERCIAL AREA

ENVIRONMENTAL ELEMENTS / LAND-USE OPTIONS	RELIEF	GEOPHYSICAL	HYDROLOGY	POLLUTION	FLORA	FAUNA	TRANSPORT	WET SERVICES	OTHER SERVICES	HISTORICAL	DEMOGRAPHY	LANDUSE&OWNERS	ZONING	POLICIES&PLANS	SOCIAL ISSUES	LOCATION
EDUCATION	-1/1	2/2	-2/1	-2/2	1/1		2/2	2/1	2/1		2/1	3/3	-3/1		2/3	2/2
EMPLOYMENT	-1/1	2/2	-2/3	-1/1		1/1	2/3	2/3	2/3		2/3	3/3	-2/3		2/2	2/2
HOUSING	-1/2	2/2	-2/3	-2/2	1/1	1/1	2/3	2/3	2/3		2/3	3/3	3/3		2/3	2/3
PUBLIC FACILITIES		2/1		-2/2	2/2		2/3	2/1	2/1		2/2	3/3	-3/1		2/3	2/3
TRANSPORTATION	-2/2	2/2	-2/2		2/1	2/1	2/2				2/2	3/3	-3/2		2/2	2/2
HEALTH	-1/1	2/2	-2/1	-2/2	1/1		2/3	2/3	2/2		2/2	3/3	-3/1		2/3	-1/3
CONSERVATION			2/2	-2/2	-2/2						-2/2	2/2	-3/1		-2/2	2/1

MAP REFERENCE: F
LAND OWNER: CAPE TOWN CITY COUNCIL
LAND USER: GOLF DRIVING RANGE

ENVIRONMENTAL ELEMENTS / LAND-USE OPTIONS	RELIEF	GEOPHYSICAL	HYDROLOGY	POLLUTION	FLORA	FAUNA	TRANSPORT	WET SERVICES	OTHER SERVICES	HISTORICAL	DEMOGRAPHY	LANDUSE&OWNERS	ZONING	POLICIES&PLANS	SOCIAL ISSUES	LOCATION
EDUCATION	2/1	2/2					2/2	2/2	2/2		2/2	-2/2	2/2	-2/3	?	2/2
EMPLOYMENT	2/2	2/2					2/3	2/3	2/3		2/2	3/2	3/2	2/3	?	-2/2
HOUSING	2/2	2/2					2/3	2/3	2/3		2/2	2/2	2/2	-2/3	?	-2/2
PUBLIC FACILITIES	2/1	2/2					2/3	2/2			2/2	-2/2	-2/1	-2/3	?	2/2
TRANSPORTATION	2/1	2/2					2/2				2/1		-2/1	-2/3	?	-2/2
HEALTH	2/1	2/2					2/3	2/3	2/3		2/2	3/2	-2/1	-2/3	?	2/2
CONSERVATION		2/1			-2/2		-2/2			-2/2	-2/2	-2/2	-2/2	-2/3	?	-2/2

MAP REFERENCE: G
LAND OWNER: MEDICAL RESEARCH COUNCIL
LAND USER: SITE FOR PROPOSED GATEWAY PARK DEVELOPMENT

ENVIRONMENTAL ELEMENTS / LAND-USE OPTIONS	RELIEF	GEOPHYSICAL	HYDROLOGY	POLLUTION	FLORA	FAUNA	TRANSPORT	WET SERVICES	OTHER SERVICES	HISTORICAL	DEMOGRAPHY	LANDUSE&OWNERS	ZONING	POLICIES&PLANS	SOCIAL ISSUES	LOCATION
EDUCATION	2/1	-2/2	-2/2	-2/2	2/2	2/2	2/2	2/2	2/2		2/2	2/2	2/2	2/2	2/2	2/2
EMPLOYMENT	3/1	-2/2	-3/3	-2/1	-2/3	-2/3	2/2	2/2	2/2		2/1	2/2	2/1	-2/1	-2/3	2/2
HOUSING	3/1	-2/3	-3/3	-2/3	-2/3	-2/3	2/2	2/2	2/2		2/1	2/2	-2/1	-2/1	-2/3	2/2
PUBLIC FACILITIES	2/1	-2/2	-2/2	-2/2	2/2	2/2	2/2	2/2	2/2		2/2	2/2	3/2	2/2	2/2	2/2
TRANSPORTATION	2/1	-2/3	-3/2		-2/2	-2/2	2/2				2/1	-2/2	-2/1	-2/2	-2/3	2/2
HEALTH	2/1	-2/3	-3/3	-2/3			2/2	2/2	2/2		2/1	-2/1	3/2	-2/1	2/2	2/2
CONSERVATION			3/2	-2/2	3/3	3/3	-2/2				-2/2	2/3	2/2	3/2	2/3	3/2

MAP REFERENCE: H
LAND OWNER: CAPE TOWN CITY COUNCIL
LAND USER: RAAPENBERG BIRD SANCTUARY

ENVIRONMENTAL ELEMENTS / LAND-USE OPTIONS	RELIEF	GEOPHYSICAL	HYDROLOGY	POLLUTION	FLORA	FAUNA	TRANSPORT	WET SERVICES	OTHER SERVICES	HISTORICAL	DEMOGRAPHY	LANDUSE&OWNERS	ZONING	POLICIES&PLANS	SOCIAL ISSUES	LOCATION
EDUCATION	2/1	2/2		-2/2			2/2	2/2	2/2	2/2		3/2	3/2	2/2	?	2/2
EMPLOYMENT	2/2	2/2		-2/1		-2/2	2/3	2/3	2/3	-2/2		2/2	-2/1	-2/2	?	2/2
HOUSING	2/2	2/2		-2/2		-2/2	2/3	2/3	2/3	-2/2		-2/2	-2/1	-2/2	?	2/2
PUBLIC FACILITIES	2/1	2/1		-2/2		2/2	2/3	2/2	2/2	2/3		2/2	3/2	2/2	?	2/2
TRANSPORTATION	2/1	2/2				-2/2	2/1			-2/2		-2/2	-2/2	-2/2	?	-2/2
HEALTH	2/2	2/2		-2/2			2/2	2/2	2/2			2/2	2/2	-2/1	?	2/2
CONSERVATION				-2/2	-2/2	2/2				2/3		2/2	-2/1	2/2	?	2/2

MAP REFERENCE: I
LAND OWNER: UNIVERSITY OF CAPE TOWN
LAND USER: SITE FOR HOMESTEAD DEVELOPMENT

ENVIRONMENTAL ELEMENTS / LAND-USE OPTIONS	RELIEF	GEOPHYSICAL	HYDROLOGY	POLLUTION	FLORA	FAUNA	TRANSPORT	WET SERVICES	OTHER SERVICES	HISTORICAL	DEMOGRAPHY	LANDUSE&OWNERS	ZONING	POLICIES&PLANS	SOCIAL ISSUES	LOCATION
EDUCATION	2/1	2/2		-2/2			2/2	2/2	2/2	2/2		2/2	2/1	2/2	2/2	2/2
EMPLOYMENT	2/2	2/2		-2/1			2/3	2/3	2/3	-3/3		2/2	2/3	-3/2	2/2	2/2
HOUSING	2/2	2/2		-2/2			2/3	2/3	2/3	-2/3		-2/2	-2/1	-3/2	-2/2	2/2
PUBLIC FACILITIES	2/1	2/1		-2/2			2/3	2/3	2/3	2/3		3/2	-2/1	2/3	3/2	2/2
TRANSPORTATION	2/1	2/2					2/1			-2/3		-2/2	-2/1	-3/3	-2/2	-2/2
HEALTH	2/2	2/2		-2/2			2/2	2/2	2/2	2/2		-2/2	-2/1	2/2	2/2	2/2
CONSERVATION				-2/2						3/3		2/3	-2/2	3/2	3/2	2/2

MAP REFERENCE: J
LAND OWNER: NATIONAL MONUMENTS COUNCIL
LAND USER: VALKENBERG HOMESTEAD

ENVIRONMENTAL ELEMENTS / LAND-USE OPTIONS	RELIEF	GEOPHYSICAL	HYDROLOGY	POLLUTION	FLORA	FAUNA	TRANSPORT	WET SERVICES	OTHER SERVICES	HISTORICAL	DEMOGRAPHY	LANDUSE&OWNERS	ZONING	POLICIES&PLANS	SOCIAL ISSUES	LOCATION
EDUCATION	2/1	2/2		-2/2	1/1	2/2	2/3	2/2	2/2	2/2	2/2	2/3	2/2		2/2	2/2
EMPLOYMENT	2/2	2/3		-2/1		-2/2	2/3	2/2	2/2	-2/1	2/2	2/3	-2/2		2/2	2/2
HOUSING	2/2	2/3		-2/2		-2/2	2/3	2/2	2/2	-2/1	2/2	-2/3	-2/2		-2/1	2/2
PUBLIC FACILITIES	2/1	2/2		-2/2	2/2	2/2	2/3	2/2	2/1	2/3	2/2	2/3	2/2		2/2	2/2
TRANSPORTATION	2/2	2/3					2/1			-2/2	-2/2	-2/3	-2/1		-2/2	2/2
HEALTH	2/2	2/2		-2/2	2/2		2/3	2/2	2/2		2/2	3/3	2/2		2/2	2/3
CONSERVATION				-2/2	-2/2	2/2				2/3	2/2	2/2	2/1		2/1	2/2

MAP REFERENCE: K
LAND OWNER: DEPARTMENT OF COMMUNITY DEVELOPMENT
LAND USER: VALKENBERG HOSPITAL

ENVIRONMENTAL ELEMENTS / LAND-USE OPTIONS	RELIEF	GEOPHYSICAL	HYDROLOGY	POLLUTION	FLORA	FAUNA	TRANSPORT	WET SERVICES	OTHER SERVICES	HISTORICAL	DEMOGRAPHY	LANDUSE&OWNERS	ZONING	POLICIES&PLANS	SOCIAL ISSUES	LOCATION
EDUCATION	2/1	-2/1	-3/3	-2/2	2/1	2/1	2/3	2/2	2/2	-1/1	2/2	2/2	2/3	-2/1	2/2	2/2
EMPLOYMENT	2/2	-2/1	-3/3	-2/1	-2/1	-2/1	2/3	2/2	2/2	-1/1	2/2	2/2	-2/1	-2/1	-2/2	2/2
HOUSING	2/2	-2/2	-3/3	-2/2	2/1	-2/1	2/3	2/2	2/2	-1/1	-2/1	2/2	-2/1	-2/1	-2/2	2/2
PUBLIC FACILITIES	2/1	-2/1	-2/2	-2/2	2/2	2/2	2/3	2/1	2/1	-1/1	-2/2	2/2	3/2	3/2	2/2	2/2
TRANSPORTATION	2/2	-2/2	-2/3		-2/2	-2/2	2/2			-1/1	2/2	2/2	2/2	-3/1	-2/1	2/2
HEALTH	2/1	-2/1	3/3	-2/2	2/2	2/1	2/3	2/2	2/2	-1/1	2/2	2/2	2/2	2/1	2/1	2/2
CONSERVATION			3/2	-2/2	2/2	2/2				2/2		2/1	2/2	2/1	2/2	2/2

MAP REFERENCE: L
LAND OWNER: CAPE TOWN CITY COUNCIL
LAND USER: REMAINDER OF CCC OWNED LAND - WESTERN SIDE OF BLACK RIVER

ENVIRONMENTAL ELEMENTS / LAND-USE OPTIONS	RELIEF	GEOPHYSICAL	HYDROLOGY	POLLUTION	FLORA	FAUNA	TRANSPORT	WET SERVICES	OTHER SERVICES	HISTORICAL	DEMOGRAPHY	LANDUSE&OWNERS	ZONING	POLICIES&PLANS	SOCIAL ISSUES	LOCATION
EDUCATION	2/1	1/2	-2/2	-2/1	2/1	2/2	2/2	2/2	2/2		2/2	2/2	-2/1		?	2/2
EMPLOYMENT	2/1	1/2	-3/2	-2/1	2/1	-2/2	2/2	2/2	2/2		2/2	2/2	3/2		?	2/2
HOUSING	2/1	1/2	-3/2	-2/2	2/1	-2/2	2/2	2/2	2/2		2/2	2/2	-2/2		?	2/2
PUBLIC FACILITIES		2/2	-2/2	-2/2	2/2	2/2	2/2	2/1			2/1	2/2	2/2		?	2/1
TRANSPORTATION		1/2	-3/3		2/1	-2/2	2/2				2/2	-1/2	-2/2		?	2/1
HEALTH	2/1	1/2	-2/2	-2/2	2/1		2/2	2/2	2/2		2/2	2/2	2/2		?	2/1
CONSERVATION			3/2	-2/2	2/3	2/3					2/1	2/2	-2/2		?	2/2

MAP REFERENCE: M
LAND OWNER: CAPE TOWN CITY COUNCIL
LAND USER: REMAINDER OF CCC OWNED LAND - EASTERN SIDE OF BLACK RIVER