APPENDIX C:

TOWARDS ACHIEVING BIODIVERSITY TARGETS FOR A GLOBAL URBAN BIODIVERSITY HOTSPOT

THE CITY OF CAPE TOWN'S BIODIVERSITY NETWORK

Prepared for the City of Cape Town

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EXECUTIVE SUMMARY

In 2001 as one of the first outcomes of the then newly adopted Integrated Metropolitan Environmental Policy (IMEP), the City of Cape Town's Environmental Management Department initiated a systematic conservation planning study to identify both biodiversity targets for the City as well as the network of biodiversity sites that would meet those targets. This was the first systematic conservation planning study for Cape Town, a global biodiversity hotspot.

The initial systematic conservation planning study undertaken in 2001/2002 has evolved over the last four years to include a number of key biodiversity conservation concepts with the explicit intention of integrating biodiversity goals within a highly developed and developing urban environment. These concepts and approaches were developed through ongoing debate and discussion between the City officials and the consultant team and resulted in a number of phases in the development of the biodiversity network. These phases and key concepts that were developed over the last four years include:

- Three external reviews of the conservation planning methodology
- Inclusion of species data
- A friction analysis to identify corridors and connectivity
- Identification of all conservation management models
- Prioritisation of the network into categories A, B and C
- The concepts of biodiversity nodes and anchors
- Landuse planning and regulation of the network through a Red-Flagging system

The evolving development of the Biodiversity Network and the key concepts that have been applied was largely a result of the continuity of a small team of City officials and consultants over the last fours years. This continuity greatly expanded the scope of concepts that have been developed and applied to the methodology. Central to this continuity were officials from the City's Environmental Management Department as well as lead consultants Marlene Laros and Grant Benn.

This document summarises and expands on the thinking behind the development of each of these aspects of the Biodiversity Network and reflects the methodology that was applied in applying these concepts to a complicated systematic approach.

1. URBAN CITIES AND NATURE

Introduction

Cities are universally understood as areas of intense development, industry, economic activity and high human population densities. City forward planning and development has therefore primarily focussed on achieving growth, both economically and in terms of infrastructure and urban efficiencies. Planning for open spaces and natural areas within cities has tended to lag behind the rate of development and was often not considered a primary function and component of the urban fabric. Historically, natural areas and development were considered mutually exclusive. Cape Town's Greening the City Report (1982) noted that development of open space and recreation amenities lagged behind that of development while at the same time, on a city-wide scale, managed and maintained open space was unevenly distributed with impoverished areas having little if any formalised and managed open space within densely populated areas leading to environmental poverty and social inequity.

In the past, under the umbrella of development, rivers were canalised, wetlands filled in, open space earmarked for housing development and natural vegetation removed and replaced with exotic vegetation. Natural remnants were consigned to nature reserves, islands within a sea of urban development, fenced and managed as distinct areas, removed from the urban fabric and poorly integrated into the social environment.

In recent times however, nature and natural areas have become more and more recognised as essential components in the urban and human environment. Not only is the focus shifting towards a greater realisation of the need to conserve and protect the natural heritage - as the world as a whole recognises that with current trends much of global biodiversity will be lost -, but more importantly nature and natural areas are being recognised for the essential services they provide, economically, socially, recreationally, spiritually, educationally and in maintaining and enhancing healthy living environments. Further, historical concepts of conservation being limited only to formalised nature reserves is being challenged by a new paradigm of more integrated, functional and accessible spaces that support a range of needs and activities making conservation and natural areas a greater part of human settlement.

This document presents a spatial and conceptual conservation and development plan for the City of Cape Town. This plan was developed through scientific analysis and the application of a core set of concepts and principles. Successfully implemented, this natural spatial framework will ensure the protection and enhancement of the City's unique and threatened biodiversity, the integration of natural areas into the urban environment, the maintenance of natural environmental services, the provision of quality open space for recreation and a healthy living urban environment for the communities of Cape Town.

1.1 Biodiversity: a definition

Biodiversity (biological diversity) is the totality of the variety of living organisms, the genetic differences among them, and the communities and ecosystems in which they occur. Biodiversity is all the living parts of nature that depend on soil, water, air and habitat for survival. It is the 'natural wealth' of the earth, which supplies all our food and much of our shelter and raw materials. In the context of Cape Town, biodiversity refers to the variety of living organisms, which occur naturally in the Cape Town area. The value of biodiversity can be measured in its:

- Economic value of functioning ecosystems (e.g. clean water and clean air)
- Intrinsic value through its mere existence
- Contribution to tourism
- Consumptive use value e.g. harvesting
- Educational value
- Social value through recreation and open space
- Aesthetic value through beauty and scenic drives
- Health and wellbeing
- Spiritual value

- Bequest value – the value of retaining biodiversity for future generations
- Option value – the value of retaining biodiversity for future use

For the purposes of this document, areas in which biodiversity occurs and which have been identified as important for biodiversity are referred to as "natural areas" as it is here that nature, naturally occurring species and natural processes persist.

1.2 The City of Cape Town's Unique Biodiversity

The CCT is located within an area of world-class biodiversity and unique conservation value and is a global urban biodiversity hotspot without parallel (Mittermeier *et al*, 1998; Olson & Dinerstein, 1998, Myers, 1990). This is a result of both the inland aquatic and terrestrial ecosystems and the diverse coastal and marine habitats created by the warm waters of False Bay and the colder waters of the Atlantic Ocean. The City is located within the Cape Floristic Kingdom, the smallest of only six floral kingdoms in the world. The Cape Floristic Kingdom is not only the smallest of the world's floral kingdoms but is also one of the richest with a high proportion of endemic (i.e. species which occur nowhere else in the world) and endangered species. As a result, the Cape Floristic Kingdom is known as a "global hotspot", placing an international responsibility on the CCT, Provincial Government and National Government to ensure the adequate conservation thereof. The Cape Town Lowlands (Cape Flats), an area that to date has been under-conserved and has experienced massive urban sprawl due to Apartheid planning policies, alone, supports more than 1466 different plant species.

Some of Cape Town's biodiversity facts:

- South Africa has the second highest number of plant extinctions in the world
- Cape Town contains remnants of the threatened Renosterveld vegetation of which only 3% remains of its original extent, making it one of the most endangered vegetation types in South Africa, if not in the world.
- 70% of the Cape Floral Kingdom's 9 600 plant species are found nowhere else on earth
- The Cape Town Lowlands (Cape Flats) of the CCT has the highest concentration of threatened plants per area of remaining vegetation in the world
- The Cape Town Lowlands (Cape Flats) of the CCT support more than 1 466 plant species in 1 874 km^2 of which 76 are endemic and 131 red data species
- The Cape Peninsula Mountain Chain supports 2 285 plant species in 471 km^2 of which 90 are endemic.
- 41 mammal species remain in Cape Town with six recently extinct
- 250 bird species live in Cape Town -- ten are endangered and at least three species have become extinct in recent years
- There are approximately 111 endemic invertebrate species on the Cape Peninsula Mountain Chain alone
- There are 18 amphibian species in Cape Town of which four are listed in the Red Data Book
- 48 reptile species, of which four are endangered and two are locally extinct, are found in Cape Town
- 24 fish species are dependant on Cape Town's estuaries for their survival

1.3 City of Cape Town: An Urban Centre

The CCT is situated at the southwestern tip of Africa and his home to approximately 3,2 million people. The CCT, a recent amalgamation of a number of local municipalities into one metropolitan area or uni-city, administers an area of 2400km^2. Like all South African cities and towns, Cape Town developed within the context of Apartheid policies and laws resulting in an urban city that still today has many social and economic inequalities. As a result, Cape Town is a mix of well-developed advantaged suburban and urban areas surrounded by impoverished, environmentally poor disadvantaged areas characterised by massive informal settlements and urban sprawl. Inequitable access to economic and social opportunities, quality open space, healthy living environments, natural resources and natural assets remains a legacy of Apartheid planning and policy.

Cape Town as a city does not have significant and major industry comparable with that of other major South African cities and other developing cities across the globe. An active port, financial sector, hospitality industry, textile and fishing industry are supported by wine farming, the filming industry and limited sand mining opportunities as the main contributors to the economy. Major industry on a large economic scale, significant mineral resources and a highly productive agricultural sector are lacking in terms of primary sources of economic growth and development. Much of Cape Town's economy and growth is supported and underpinned by its natural beauty and heritage. Cape Town is internationally recognised and renowned as one of the most beautiful cities in the world. This recognition has stimulated and resulted in a growing and significant tourism industry, rapidly increasing property values and increased high-income development in Cape Town. With its unique and beautiful natural environment, 307 km of coastline and the Table Mountain National Park within the City boundaries, there is an increasing global desire to live and work in Cape Town. As such it is imperative that the natural resources and landscapes of Cape Town are protected and enhanced so as to protect and manage Cape Town's greatest economic and social asset.

1.4 Historical Approach to biodiversity and natural resource management

The transformation of natural environments in Cape Town, through progressive urbanisation and agricultural development, has severely impacted on the lowland habitats and their associated vegetation types. Growing rates of human in-migration to urban centres, the resultant urban sprawl, a development boom and increasing value being associated with property in proximity to the coastline and natural landscapes has, and is, severely threatening the City's remaining natural environment. Of the four primary vegetation types found in Cape Town (sand plain fynbos, dune thicket, west coast renosterveld, mountain fynbos) two lowland types, namely sand plain fynbos and west coast renosterveld are under extreme threat. Sand plain fynbos has less than one per cent remaining on the Cape Flats (Wood *et al*, 1994) while less than 3% of the total original extent of west coast renosterveld remains in the Cape Floral Kingdom, with little of this formally conserved in protected areas. (Wood & Low, 1993; McDowell, 1995). The remaining remnants of these vegetation types within Cape Town contribute significantly to the overall conservation of these highly threatened and fragmented vegetation types that are unique to the Cape Floral Kingdom (CFK).

To date the protection and enhancement of natural areas and biodiversity was undertaken in a fragmented and ad hoc approach. This was driven by many factors but significantly through the structure of the previous dispensation. Under the previous dispensation no less than nine government organisations were responsible for the protection of biodiversity in what is now the CCT. This included seven local authorities, the Western Cape Nature Conservation Board and South African National Parks. Little coordination and integration of efforts and approaches between these organisations took place resulting in the fragmented approach to biodiversity and little city-wide planning. Historically, however, the spectacular Peninsula Mountain Chain received more attention than the Cape Town Lowlands (Cape Flats), which were neglected under apartheid planning. Prior to 1982 a few reserves were proclaimed such as Tygerberg Nature Reserve and the Rondevlei and Zandvlei Bird Sanctuaries (both now renamed as nature reserves). Most of these reserves were proclaimed on a site-specific basis, i.e. sites were not identified in a systematic way that prioritised areas on the basis of their contribution to pre-determined conservation targets for the entire City or within a city nature area framework.

In 1982, the then Cape Town Municipality (a much smaller area than the now Cape Town Uni-City) produced a forward thinking and widely recognised and acknowledged report, the Greening the City Report. Although produced in 1982 this report is still widely recognised today as a key and leading framework for a city planned around functional, healthy and living environments. The key recommendations and proposals within the 1982 report were never successfully implemented in their entirety. The report, which identified some areas as conservation priorities, formed the basis for much of the conservation work that followed and was adopted by the then City of Cape Town's Council in 1984. As one of the results, the Wolfgat Nature Reserve was proclaimed in 1986.

At the same time a project funded by the government under the Fynbos Biome Programme, was launched to identify conservation priorities in lowland regions of the Fynbos Biome. The resultant Jarman Report identified many priority conservation areas in the City of Cape Town. Despite its value, this report never received political backing and none of its recommendations were implemented. Many of the priority sites identified therein were lost to the massive expansion of urban areas on the Cape Flats from the mid 1980s onwards. Political pressure and urgency to accommodate a large number of migrants to the city marginalised conservation concerns.

In the late 1980s and early 1990's several flora surveys and vegetation mapping exercises were conducted to identify conservation-worthy areas. In 1990 a report entitled "Conservation Priority Survey of the Cape Flats", which identified and mapped important conservation areas, was published. The study identified sites such as Kenilworth Racecourse and was critical in raising awareness – at least amongst conservationists - about the plight of Cape Town's biodiversity. In 1992 the then City of Cape Town Council accepted the recommendations of this study and used it as a reference document to guide decision-making with respect to future development proposals. Despite this Council resolution, the report failed to mobilise significant action and the Council adopted a passive role, particularly when dealing with areas threatened by development. There was no clear or organised strategy for implementation, no delegated body responsible for implementation, and the findings of the report were not communicated to a sufficiently wide audience.

In the early to mid 1990's many of the larger remnants were lost to development while others, even some with protection status (local and provincial nature reserves) gradually degraded, owing to lack of on-the-ground management (e.g. the Driftsands Nature Reserve). Between 1994 and 1997, the attention of government and civil society was focused on the consolidation of conservation areas and management on the Peninsula Mountain Chain, which culminated in the establishment of the Cape Peninsula National Park in 1998. The establishment of the Cape Peninsula National Park (now called the Table Mountain National Park) is now complete, thereby relieving local and regional government of a large part of its conservation management responsibilities on the Peninsula Mountain Chain portion of the CCT. In 1997 the Botanical Society of South Africa, an NGO dealing with flora conservation issues in Cape Town, launched a study to identify flora conservation priorities, based on the principles and practices of target-driven systematic conservation planning. This resulted in the Cape Flats Flora Core Conservation Sites project, in which 37 Core Flora Conservation Sites were identified as critically important to the overall protection of biodiversity in Cape Town.

Although facing rapid urban growth and development on a scale never before experienced in Cape Town, the opportunity to secure a representative suite of functional open spaces and natural areas as part of the urban landscape that would fulfil a multipurpose function of conserving biodiversity, providing social and economic opportunities, recreation, greenbelts, healthy living environments and environmental services still exists.

1.4 Importance of biodiversity and nature within the urban context

A long held paradigm was that nature conservation only took place through the establishment of large formal reserves in rural areas and on the fringes of urban settlements. Within this paradigm the historical thinking was one of delineating and fencing areas, restricting activities and land use types and securing land in its most basic state for the purpose of providing space for the existence of natural habitat and thus freeing remaining land for development and land use change. This paradigm has begun to change with a greater global focus on integrated landscapes and multipurpose natural areas that provide a range of natural and human services and functions. There is a greater blurring of the distinction between protected conserved land and utilised land. Within this newer approach to conserving natural spaces and habitats there will however, always be a strong role for large well managed and secured nature reserves. This document does not suggest or intend arguing against such important aspects of the South African landscape. However, the focus of this document is on a much more challenging and uplifting approach, that of integrating urban settlements and land uses with nature, of viewing landscapes as integrated multifunctional areas promoting and underpinning sustainable development for both current and future development.

Historically, urban centres and nature conservation were considered mutually exclusive, the one competing with the other for space and resources. Two issues emerge within this context, on the surface separate and distinct, but after consideration, integrated and holistic.

The first is the valuable role and importance of open space within urban centres. These open spaces provide for recreation, social and spiritual upliftment and islands of escape for urban dwellers from the sometimes "concreteness" of cities. One has to look no further than international cities such as New York City and Hong Kong to understand the enormous value attached to open space. Central Park in New York City is potentially and arguably some of the most valuable real estate in the world, yet it is retained without question as open space. Many other examples of the value of open space within highly developed first world cities exist, from Hong Kong to London, and here in Cape Town where the

Table Mountain National Park is central to what defines Cape Town as an international city. On consideration it is the naturalness of these open spaces within the urban environment that defines their value. The existence of tranquil green spaces with vegetation, water, animal life, birds and soil creates the value of the open space. These open spaces provide urban dwellers and opportunity to recreate, walk their pets, revitalise and energise themselves and find quiet moments in an otherwise built environment. These open spaces play a further role as linkages and access routes within the urban environment.

The second issue is one of conserving and protecting all of the biodiversity that exists on earth for both future and current generations. Historically cities developed due to economic and social reasons, the presence of mineral resources, strategic sea routes, safe harbours, trade and transit routes. Cities and their locations were not defined or identified on selecting areas that were biodiversity poor or naturally appropriate, but rather on social and economic needs. Consequently, cities may find themselves within biodiversity rich areas. A number of examples exist, including Sydney, Australia, Rio De Janero Brazil and Cape Town South Africa where a city exists within areas of extremely high and important global biodiversity. The responsibility to protect biodiversity of global importance falls to the city administration and its decision makers and planners. The importance of this second issue is further enhanced with a greater realisation and recognition of the role and importance of environmental services to both the population and the city. These environmental services include water management (provision and purification), flood attenuation, air quality, natural resource use and provision.

There is thus a significant opportunity to combine the two issues within a city wide planning approach to meet a range of urban needs and goals. By establishing a city-wide network of interlinked open spaces that protect and enhance biodiversity, provide environmental services and contribute to social upliftment through recreation and quality urban open space, a vibrant and healthy urban living environment can be achieved that underpins and supports the economy while protecting and enhancing existing natural assets.

A consolidated, functional and representative urban network of connected natural spaces would have the following benefits to any urban environment, but in particular the City of Cape Town:

- Conservation and protection of a representative set of the unique and threatened biodiversity in Cape Town
- Enhanced long term viability of natural areas through ensuring adequate linkages and corridors between natural areas
- Sufficient quality open space for recreation and a range of social needs
- Provision and maintenance of environmental services
- Opportunity for market gardens and food production within the urban context
- Economic opportunities associated with tourism
- Opportunity for alternative transport access routes (bicycle routes)
- Lower cost of management and maintenance (local indigenous vegetation as opposed to exotics, wind blown sand management)
- Recreation opportunities within easy access and proximity to all communities
- Maintenance and enhancement of property value
- Opportunities for education and the fostering of an ethic of collective responsibility.

Finally, there is also a legal and delegated responsibility for government at all levels for responsible stewardship of the resources within its charge.

2. CITY-WIDE NATURAL AREA PLANNING AND METHODOLOGY

2.1 Institutional Context

The City of Cape Town administers a wide range of functions and service delivery through a number of line functions and directorates reporting to a number of executive directors and finally the political sphere or Council. Each line function or directorate has specific functions and duties and management responsibilities. This organisational design lends itself to polarisation, establishment of management silo's and complicated city-wide planning. While one line function may plan on a city wide scale, the implementation of that planning takes place very often through a separate directorate or line function. Therefore one of the greatest challenges in realising a vision of a city with a set of interconnected open spaces and natural areas is integrating across and within the various line functions and directorates. This integration needs to occur not only at the beginning of the planning and analysis stage but must be maintained throughout the planning and into implementation and management. The methodology and conservation analysis and planning described in Chapter 3 of this document was undertaken within this context. As such the approach evolved and was driven through the framework of the Integrated Metropolitan Environmental Policy (IMEP) and the City's Biodiversity Strategy.

2.1.1 The Integrated Metropolitan Environmental Policy (IMEP)

Following a lengthy, consultative and integrated approach, the City of Cape Town (CCT) formally adopted the Integrated Metropolitan Environmental Policy (IMEP) along with its implementation strategy, the Integrated Metropolitan Environmental Management Strategy (IMEMS) on the 31st October 2001. IMEP sets the overall environmental principles and framework for the City of Cape Town while the IMEMS is the implementation mechanism for achieving the sustainable development principles within IMEP. IMEMS requires that the CCT develop detailed sectoral strategies, across line functions and directorates, to meet the wide range of commitments made in the sectoral approaches of IMEP by giving effect to the environmental principles in IMEP.

During the IMEP development process six priority strategies were identified for implementation within two years of the adoption of IMEP. One of these strategies is the Biodiversity Strategy.

2.1.2 City of Cape Town Biodiversity Strategy

In October 2003 the City of Cape Town formally adopted the Biodiversity Strategy and as such committed itself to protecting, optimising and enhancing the unique biodiversity found in Cape Town. A strategy is defined as "a systematic plan of action to accomplish a specific goal". The Biodiversity Strategy therefore aims to be an organised systematic approach working towards ensuring that the rich variety of indigenous naturally occurring living organisms found in Cape Town are protected and enhanced for both current and future generations while the economic potential of biodiversity in Cape Town is optimised.

Central to the Biodiversity Strategy are seven Strategic Objectives, which set the framework for adequately, and effectively ensuring the enhancement and protection of biodiversity and the integration of biodiversity into the urban fabric as both a social and economic resource. Central to all seven of the strategic objectives is the planning, development and implementation of a network of biodiversity or natural areas consisting of both primary and secondary biodiversity areas. Primary areas refer to areas that are fundamentally areas set aside for conservation and secondary biodiversity areas those that fulfill a greater and more multifunctional and multipurpose role. This concept of dual-purpose biodiversity or natural areas, a central, binding and key theme within the whole network, will be discussed in much greater detail in Chapter 4.

Therefore it was within this overarching framework of IMEP and the City's Biodiversity Strategy that the planning and analysis was done to identify a network of biodiversity areas or natural areas and define a set of core and central concepts and principles for implementation.

2.2 City-wide Conservation Planning: An Argument For.

Although the main theme throughout this initiative and this document is the establishment of a network of interconnected natural spaces that fulfil a multiple role of conserving biodiversity, providing recreational and social space, maintaining environmental services and enhancing economic opportunities, conservation planning and analysis was selected as the key tool for identifying the preliminary set of natural areas.

The central argument around this choice of tool was that of all the functions of the network of interconnected natural spaces, biodiversity and the range of habitats within the city was the most defining and immovable characteristic and aspect. In other words, biodiversity and the conservation of the spectrum of habitat and species would form the core identifying and determining factor for the selection of natural areas. This rationale allows for the systematic conservation of the full range of habitat and species while securing the social and economic aspects through the implementation of the network. Explained in another way, if social and economic factors were used as the basis and core of identification, there would be a strong likelihood/certainty that a number of habitats and species would be excluded from the final network thus undermining the very principles of the network.

In the most simplest terms, the conservation and planning analysis tool chosen uses a range of criteria to identify and select a range of remaining natural spaces, that in addition to existing nature conservation areas, would include and cover sufficient representative sets of all habitats and species found within Cape Town. In other words the analysis asks the question of, what spaces do we need to protect as natural areas, in addition to the existing ones, in order to ensure that a viable population of all the different species and the full range of habitat that occur in Cape Town, would be adequately represented so as to have a strong likelihood of survival into the long-term future. The detail of the conservation analysis and descriptions of the criteria used to determine these targets and areas is discussed in detail in Chapter 3.

Once the preliminary set of biodiversity areas has been identified using the conservation analysis, a logical approach to the application of a number of social and economic, as well as implementation, principles and concepts must be applied in order to arrive at a final biodiversity/natural area network. This logical approach of applying a number of key concepts and principles is presented in section 2,4 below and discussed in detail in Chapters 4 and 5.

However, before any conservation analysis and planning can commence, a clear understanding of existing protected and natural areas is needed as the analysis would identify natural areas that are needed in addition to existing formal protected and natural areas.

2.3 Current state prior to analysis

In August 2000 an assessment of protected areas in the Cape Metropolitan Area – legal and management considerations for Local Government (K Hoo-Mi Sloth, Environmental Management Department, August 2000) was undertaken as the initial assessment of conservation in the metropolitan area. This assessment undertook an institutional approach to understanding and identifying problems assess the cause of problems and make policy recommendations for future strategy and management of protected areas. The assessment found that protected areas in the metropolitan area had been proclaimed on arbitrary criteria and unclear objectives while other conservation worthy sites did not have any protection. The study recommended that a city-wide conservation planning approach be adopted and both in the establishment of clear objectives as well as the distribution of management resources.

Prior to the conservation analysis being undertaken a number of National, Provincial and Local Government Nature Reserves had been proclaimed over a number of years and for differing reasons and objectives. Thus, prior to the assessment the following set of protected areas with differing conservation status was in existence:

Protected areas and their conservation status

Protected Area Name	**Conservation Status**
Kogelberg Biosphere Reserve	Biosphere Reserve

Kirstenbosch	Botanical Gardens
Rondebosch Common	Declared National Monument
Blouberg Fynbos	Declared National Monument
Cape Flats Nature Reserve	Declared National Monument
Durbanville Nature Reserve	Local Authority Reserve
Plattekloof Farm	Local Authority Reserve
Wolfgat	Local Authority Reserve
Westlake	Local Authority Reserve
Tygerberg Hill	Local Authority Reserve
Rondevlei	Local Authority Reserve
Bracken	Local Authority Reserve
Brackenfell	Local Authority Reserve
Edith Stephens	National Botanical Institute
Cape Peninsula National Park	National Parks
Plattekloof	Natural Heritage Site
Klipheuwel Radio Station	Natural Heritage Site
Silwerboomkloof	Natural Heritage Site
AECI	Natural Heritage Site
9 Division	Natural Heritage Site
Somchem	Natural Heritage Site
Altydgedacht	Natural Heritage Site
Joostenberg Hill	Natural Heritage Site
Forest Hill	Natural Heritage Site
Blouberg Fynbos	Private Reserve
Koeberg Nature Reserve	Private Reserve
Name Unknown	Private Reserve
Name Unknown	Private Reserve
Name Unknown	Private Reserve
Lourens River	Protected Natural Environment
Rietvlei	Protected Natural Environment
Driftsands	Provincial Nature Reserve
Cecilia	State Forest
Tokai	State Forest
Dassenberg Hills (Site 10)	Unknown
Coastal Corridor	Unknown
Witsand	Unknown
Klein Dassenberg	Unknown
Schoongezicht	Unknown
Buffelsrivier	Unknown
Dassenberg Hills (Site 9)	Unknown
Brakkefontein	Unknown

In addition the 1997 study undertaken by the Botanical Society of South Africa, an NGO dealing with flora conservation issues in Cape Town, to identify flora conservation priorities, identified 37 Core Flora Conservation Sites as critically important to the overall protection of biodiversity in Cape Town. Although most of these 37 Core Flora sites were never given formal protection status, their status as Core Flora Sites was recognised by administrations and institutions and resulted in them having some form of practical or though not legal protection.

In summary, the methodology for the systematic conservation planning and analysis was designed to identify the set of open natural spaces that would be needed, in addition to the protected areas listed above and the 37 Core Flora sites, in order to ensure that all species and habitat within Cape Town would have the opportunity for long term survival within the urban environment.

2.4 Logical approach

The process to identify, implement and manage an eventual network of natural areas that conserves the rich biodiversity of Cape Town as well as provides social and economic opportunities has a number of phases or steps that need to be undertaken.

Each of these steps or phases is discussed in detail in the following chapters but the progression of phases or steps is represented in a flow diagram below.

Develop a conservation planning and analysis methodology
Review and assess international conservation planning models, identify data requirements, understand data availability and prepare a conservation analysis best suited to the available data and situation

Undertake the analysis and present a preliminary set of results
Undertake an initial analysis and present results for review and discussion. Assess results according to known information and identify obvious omissions

Have the methodology and results externally reviewed
Appoint a external review specialist to assess and review both the methodology and the results

Revise methodology according to the review and finalise results
Revise the initial methodology and improve the outcomes through applying the recommendations made by the external review. Rerun the analysis and develop a final set of results

Establish and define a core set of principles and approaches for implementation and apply these to the results
Implementation of a suit of natural areas protected as formal nature reserves as part of the urban fabric is both impractical and undesirable. A set of principles and approaches must be developed to better integrate the identified natural areas into a more mixed use, multifunctional approach that also meets social and economic needs of a city

Investigate and understand the full range of conservation management models that could be applied to the suit of natural areas
A full suit of natural areas that would consist of formal nature reserves, mixed use areas and multipurpose areas will need to be managed and given various forms of land use status. One single model and approach to this diverse set of areas is inappropriate. Therefore the full set of management models and options must be investigated and identified.

Integrate the implementation of the network of natural areas within a broader urban open space framework
The final implementation of the suit of natural areas must be integrated within a broader city spatial framework and development plan.

Each of these key steps and phases is discussed in detail in the following chapters. However, in terms of the conservation and planning analysis only the final methodology and results is discussed in detail. The initial development of a methodology as well as the external review and revision are described briefly below.

2.5 Development of conservation planning and analysis methodology

Development of conservation planning techniques began in the 1980's with the application of simple computer algorithms to the problem of identifying minimum sets of conservation sites. These algorithms became known as iterative selection procedures because they worked by iterating through a set of candidate areas. At each step, the best area was selected according to various selection rules based on specific criteria such as the representation of species richness. Algorithms vary widely in efficiency, but give some flexibility in that starting conditions or the criteria for selecting areas can be altered. As algorithms were used more widely, so potential limitations were identified, a case in point is where algorithms selection often concluded with selected areas being unevenly distributed across the study area, resulting in a widely dispersed reserve network. A widely dispersed reserve network is difficult to manage and may foreclose the desired option of linkages among reserves. A later approach known as Gap Analysis was developed in the United States as a US based, nation-wide scientific programme for identifying the degree to which animals and communities are represented in existing conservation areas. Those species and communities not adequately represented in the existing network of conservation lands constitute conservation "gaps." These gaps then become the focus of conservation attention. The purpose of the Gap Analysis Program (GAP) is to provide broad geographic information on the status of species and their habitats to help in a broad decision-making framework.

To achieve this goal, GAP produces a number of maps that are overlain with each other in a Geographic Information System (GIS). A later technique known as BioRAP comprises a series of computer techniques or programmes, developed for the rapid assessment of biodiversity. Various computer programmes or tools are used to predict the distribution of species or vegetation communities. The predicted distributions are then used to select priority areas for the conservation of biodiversity.

Environmental data are the fundamental component of the rapid assessment of biodiversity particularly since terrain and climate are dominant controls on biological and agricultural activity that influence the natural environment. The spatial predictions (or maps) are based on identifying those regions which have the environmental conditions that matches those of specific species and locations.

Conservation planning and analysis advanced through Noss and Franklin in the early 1990's addressing the issue of equating biodiversity and species richness. In essence, this meant that species, and these other biodiversity elements, were positioned within a hierarchy of biodiversity. Even more important, was the formal recognition that biodiversity elements were inexorably linked to biological processes.

Reserve selection methods in the 1990's began to reflect this broader understanding of biodiversity as proposed by Noss. The last two methods outlined embrace this broader concept to varying degrees. However, it must be realised that, even with the best intentions and understanding in the world, the adoption of a method to identify priority areas for conservation attention is always limited by the quality and quantity of available information. Often, this information that is required to best represent biodiversity is, at best, difficult to obtain. Even though the use of a wider range of data, as suggested by Noss (1990), may still be better than using species data only, many researchers are more comfortable with using species data which they consider to be the currency of conservation or of biology.

As summarised, there are several methods available to identify areas for inclusion into a natural area network. Sufficient research and practical consideration of the results of these models has occurred to render the majority of these methods appropriate for use. However, as with any series of choices, the requirements of each particular study and the available data need to be assessed before a decision is made. In particular, research over the last two decades has revealed that there are a number of essential components that must be considered when a reserve selection method is used. A brief survey of these considerations follows.

2.5.1 Identification of surrogates (measures) for biodiversity

Considering the complexity of biodiversity and the incomplete understanding of this complexity, conservation planning relies on measures or indicators of biodiversity commonly referred to as surrogates. In other words, these surrogates (certain chosen plants or animals) are deemed to represent all the plants and animals that may occur in an area. The choice of surrogates is critical to the meaningful execution of conservation planning. Unfortunately, this choice is often dictated by the availability of data and the time and resources available for compiling new data. As such, the choice is often made by available data. This approach has inherent biases and flaws. To alleviate these biases and flaws no surrogate should be considered paramount, but rather a combination of surrogates representing elements from across the biodiversity hierarchy should be used. Shortfalls in the data set used must be recognised upfront and the final results interpreted in the light of these.

2.5.2 Setting targets

Broadly, conservation planning has the goal of conserving a representative sample of biodiversity in a network of protected areas. Therefore to successfully identify the suit of natural areas it is important that specific, preferably quantitative, conservation targets be described for each element of biodiversity being considered. Target setting is critical because it provides planners with a goal, against which they can assess the current situation and then choose candidate areas to attain these targets. It also allows for a measure of implementation in terms of meetings those described goals and measuring long-term success of the initiative. Margules and Pressey (2000) suggested a number of characteristics, which should be borne in mind when setting targets. Targets should:

- focus on scales finer than regions or countries (in this case the targets were set for an area of 2400km2)
- include process and pattern;
- reflect the unique requirements of the biodiversity elements being considered;
- be flexible in the face of socio-economic changes.

Conservation planning is an explicitly spatial exercise, so targets are often expressed in terms of percentage area. The most commonly used " conservation target" is the IUCN 10% rule which specifies that 10% of a vegetation type or species distribution should be set aside for conservation. However, this target has been severely criticised as being too simplistic and not generally applicable. These criticisms are valid, and approaches have been developed for setting targets adjusted by factors such as rarity and vulnerability to threat. As such a whole range of ecological factors (e.g. importance of connectivity, Population and Habitat Viability) must be considered in setting targets.

2.5.3 Complementarity / Efficiency.

Complementarity refers to the selection of reserves that do not conserve the same species but act as complements to each other. In other words, the analysis when asked to select additional areas will choose areas that contain biodiversity elements not already included in existing or chosen areas in a stepwise fashion. If Site One is chosen and it contains species A, B and C and Site Two has species A, C and E, while Site Three has species A, D and E, the analysis will choose Site Three over Site Two as Site Three better compliments Site One in adding additional biodiversity elements. This is an important approach as it allows for the most efficient selection where there is competition for land by different land uses and prevents selection of redundant areas.

Caution must be utilised when using complementarity as it can lead to certain species (biodiversity elements) being present in only one of the final selected areas and thus making it susceptible to threat. Therefore complimentarity must be utilised in conjunction with other rules and choices including minimum viable populations and habitats, irreplaceability (see below), representation of each biodiversity element in more than one area (these safety factors must be included in the original set of targets) and minimising threat by spreading representation.

2.5.4 Flexibility

The minimum set of reserves refers to the smallest number of areas that can be set aside for conservation of the targeted biodiversity elements. There may be only a handful of minimum sets but a wide range of potential reserve networks that are larger than the minimum. Flexibility refers to this range of potential networks. The more alternative options that are made available to a planner, the more likely it will be to find one that maximises values of design and land suitability, reduces costs, considers other competing land claims, social and economic factors and achieves the conservation of the desired biodiversity elements. Therefore, wherever possible reserve selection methods should indicate alternatives and options for area selection.

2.5.5 Irreplaceability

The concept of Irreplaceability is one of the most important factors or rules within the conservation analysis and planning methodology. Following on from the previous topic of flexibility, irreplaceability allows for a conservation value or importance to be given to each area identified. In other words, if Site One has species A, B and C and Site Two has species A, B, C and D and species D is found nowhere else in any of the remaining areas, Site Two is irreplaceable in terms of meeting minimum conservation targets and is therefore of greater conservation value than Site One (it is the only site where species D is found). This concept of irreplaceability therefore allows the planners to choose Site Two as both a priority and a "must have" within the flexible domain of choices. It is also an important tool in distributing the often limited financial and capacity resources in terms of acquisition and management of the final set of natural areas (this priority concept is taken further and discussed in detail in Chapter 4). The irreplaceability of an area is dependent on both the conservation targets that were set upfront as well as how these targets have already been achieved in existing conservation areas. Areas with high irreplaceability must be used as the anchor points for a reserve system, around which the remaining more flexible choice of areas can be arranged using a range of factors such including area size, social and economic constraints etc.

2.5.6 Vulnerability

The concept of vulnerability, especially in an urban area experiencing significant development pressure and competition from multiple land use types is a further key concept that must be applied within the analysis and selection. Vulnerability is a term that expresses the level of threat to a natural area or species. These threats are mostly in the form of human transformation of natural habitats through land use change, but may also be due to the activities or land use type taking place on adjacent land. For example an area of natural vegetation encompassing species A, B and C surrounded by sand mining and informal housing is more vulnerable to being lost and over-run by human transformation than an area encompassing species D, E and F situated in a mountain range that is unsuitable for human habitat and activities. Areas with a high conservation value that are not faced with impending transformation should obviously be given lower priority than areas of similar conservation value which are deemed vulnerable. By combining the concepts of irreplaceability and vulnerability as key determining factors (or ways of choosing) a more comprehensive and inclusive selection and prioritisation is likely.

2.5.7 Method summarised

In summary therefore, the methodology applied in this initiative was developed using the framework provided by Margules & Pressey (2000) for systematic conservation planning which encapsulates all the steps described above and necessary to undertake a comprehensive conservation planning exercise. These steps were adapted so that they applied to the Cape Town area and included:

1. Identifying the ideal set of biodiversity surrogates (measures or indicators) for conservation planning in the Cape Town area.
2. Gather or compile data describing as many of the ideal set of biodiversity surrogates as possible. Also collect data on threats (for assessment of vulnerability) and other relevant contextual data. Due to limited resources, only available data was used.
3. Set targets for the conservation of each biodiversity surrogate being considered.
4. Identify criteria to be used for the prioritisation of candidate areas (criteria that would determine how choices must be made – these criteria are discussed in Chapter 3)

5. Review the role of the current existing reserve network in meeting the set targets and assess the imminence of threat or level of vulnerability.
6. Identify the areas needed, in addition to the existing reserve network, to attain the conservation targets, and prioritise these range of choices using the concepts of irreplaceability and vulnerability.

Finally, the natural area selection method that is chosen should produce a result that is defensible in the face of competing land uses. This is important given that there is usually a limited amount of land available for conservation. Defensibility is enhanced by seeking specialist peer review and input, from a wide spectrum of interested parties during the planning and execution phases.

2.6 Specialist Peer Review and Revision

In an effort to enhance defensibility of the outcomes, improve confidence in the final results obtained and to undertake a transparent process, the initial methodology for the study was reviewed by two external specialists and revised accordingly. The final methodology and approach was then used to undertake an initial analysis and present an initial set of results. This methodology, as well as the results obtained from the analysis, was then subjected to further review by a third specialist external review consultant.

Following this third review of both, the methodology and results, the methodology, data sets and approach were adapted and revised (where possible) according to recommendations made and the analysis repeated to achieve a final set of results.

The complete report by the specialist reviewer is available as well as detailed responses to each of the concerns and recommendations and how they have or have not been included in the final analysis.

It is essential to note that this point that this initiative was undertaken to develop, plan and implement a set of natural areas within an urban context, within which there are a myriad of competing land uses, human needs and human priorities. A number of pragmatic decisions during the analysis were therefore made on administrative and resource realities rather on pure scientific grounds and arguments. Much of the debate within the review and the responses to the review centres on an ideal scientific scenario versus a pragmatic scenario. To explain and illustrate this point further, two examples put forward as concerns by the scientific review are discussed here.

Firstly, significant concern was raised in the review on the quality and reliability of the data sets used in the analysis. As discussed earlier, the results of any conservation analysis are dependent on the type and quality of data. There is no debate on this. In an ideal scenario, where data was deemed insufficient or unreliable, new data sets would be colleted and established prior to analysis being undertaken. However, within the context of Cape Town and the complexities of the area, collecting new data and developing the perfect dataset is not only a costly exercise but also a timely one. Therefore, the most current and complete data set available was used within the analysis. The results were assessed against smaller and more incomplete data sets as a measure of check and review (this is described in greater detail in Chapter 3). However, it is recognised and stated openly that, better and more complete data sets may have yielded superior or more scientifically defensible results, but considering that only so much untransformed land remains within the study area, and that the most current and recognised data sets were used, the margin of error would not be significant enough to lower confidence in, or drastically alter the results obtained.

The second issue raised by the reviewer, is that of a size category used as a filter during the selection and choice of remnant areas. The analysis used a preferred selection filter of 10 hectares, in other words areas larger than 10 hectares were selected before areas smaller than 10 hectares. As the reviewer quite correctly points out, ecologically this size criteria is problematic as it has been shown that in even small remnants within the CFK specialist pollinator relationships can be maintained and are important to the overall conservation of the CFK. However, the decision to select larger areas first is made on a governance, efficiency of resources (both financial and staff capacity), resilience of larger areas within a densely populated urban area to threat and disturbance as well as future on-the-ground management practicalities. The choice of larger areas in addition does receive some conservation modelling support, although more generic and not specific to the uniqueness of the CFK in "In the absence of detailed information on the biology and location of an umbrella species, an alternative approach is to assign highest priority for conservation to the largest blocks of remaining habitat. Large habitat blocks typically harbour larger, more viable populations, offer greater resources and habitat diversity, support more intact ecological processes, and provide large undisturbed core areas" (Noss & Cooperrider 1994; Forman 1995; shafer 1995; Poiani 2001).

As both examples above indicate, some decisions were made during the analysis that may not always be agreed to by the scientific community. These decisions were made on pragmatic and realistic understanding of the pressures facing conservation within an urban area where the political and decision making level of government may not prioritise conservation of biodiversity at the same level as the many other social and economic factors. Conservation of biodiversity within an urban environment has to compete with many other needs and resources and as such must fit within the fabric of an urban area. Recognising that some of the decisions used within the analysis may be contentious, every effort has been made to give clear, logical and transparent explanations for why those decisions were made. Although absoluteness is never realised, it is hoped that these explanations are seen within a context of striving to achieve the best long-term outcome for biodiversity in the urban environment within social and economic needs and priorities.

3. THE ANALYSIS

As a reminder, in the most simple terms, the intention and aim of the analysis was to identify a set of natural areas that are needed in addition to the existing nature reserves and 38 Core Flora sites in the lowlands of Cape Town (Maze & Rebelo, 1999) to create the opportunity for a representative set of the complete range of biodiversity found in Cape Town to survive in the long term. A further aim of the programme is to enhance this opportunity for biodiversity by linking and connecting this network of natural areas through corridors, greenbelts and open spaces.

This Chapter describes in detail the database used, the criteria used for site selection, comparison of site selection using different data sets, the methodology for identifying a framework for biological corridors and the results from the analysis.

3.1 Data

The study was based on existing information and databases that contained relevant information on natural systems, vegetation maps, species data and spatial data. No new or primary data collection was done as part of this analysis. The availability, completeness and required updating of these databases and information affected the methodology, as well as the extent to which prioritisation of conservation areas was possible within the study. Most importantly for this study, the data used, needed to be evenly sampled across the study area (Freitag *et al*, 1998; Margules & Pressey, 2000). Data gathered unevenly will result in the erroneous exclusion, from an identified reserve system, of areas for which no data are available, clearly leading to biased results.

In an effort to use the most evenly consistent and complete data available, the study has used vegetation type as a surrogate biodiversity element for habitat (or in other words vegetation types were used as a measure of habitat).

The vegetation map used as the primary database was that developed by Low (2000), in which 15 sub categories (vegetation types) of the 4 national vegetation types identified in the national scale map prepared by Low and Rebelo (1996) were defined within Cape Town. Identification of the sub categories by Low was done on species associations and the strong correlation between vegetation and soil or geology supplemented by rainfall. In other words, geology and soil was used to define vegetation type and spatial occurrence.

The 15 vegetation types used as the primary data in the study are listed below:

Table 1: List of vegetation types present in Cape Town as used for this study

Wsh	West coast renosterveld on shale (critical)
Wg	West coast renosterveld on granite (critical)
Wq	West coast renosterveld on inland non-marine derived clay loam, loam and sand loam (granite and shale)
Dc	Dune thicket on sands
Dl	Dune thicket on sands over or on limestone
DS	Dune thicket/sand plain fynbos transition (slightly calcareous to acidic/neutral sands)
Si	Sand plain fynbos on inland non-marine derived acid sands (critical)
Sm	Sand plain fynbos on marine-derived acid sands
Sq	Sand plain fynbos on non-marine derived acid sands (recent non-aeolian colluvium)
Mg	Mountain fynbos on granite
Mgk	Mountain fynbos on granite koppies
Msh	Mountain fynbos on shale
Mshm	Mountain fynbos on shale > 800m rainfall per annum
Ms	Mountain fynbos on sandstone
Mq	Mountain fynbos on inland non-marine derived acid sands (older non-aeolian colluvium)

In order to have a starting point, or in other words, a map or layer of the remaining available untransformed land within the City from which to choose the network of natural areas, a remnant layer or map was produced. This was done by combining maps of known agricultural development, commercial properties, industrial properties, mining development, informal developments, major roads, urban areas, schools, waste sites (solid and water), railway lines, airports, metro nodes and spines, and electricity networks. This map of transformed land was then overlayed with the vegetation map and all transformed land removed (subtracted) from the remnant vegetation map. This left a map of available untransformed land from which the conservation selection could take place. This final remnant map was checked using the most recent aerial photography and through consultation with various on-the-ground managers to verify edges where possible. Where areas were identified as developed and no longer theoretically available for conservation purposes, these areas were removed from the remnant map.

Finally, additional species datasets describing the distribution of species from the family Proteaceae (Protea Atlas Project; Rebelo, 1991) and floral species lists for a subset of the remnants (Sites and Species Database; Low, 2002) were also used in the analysis. The Protea Atlas data represents the most complete and relatively evenly sampled species data set available for the study area. Similarly, the Sites and Species database represents one of the most comprehensive floral species databases available for a wide range of floral groups in the City Cape Town.

The use of species data was in part to address some of the concerns raised in the external review regarding the lack of species data as well as to assess the effectiveness of the areas selected using vegetation types in conserving known species locations. As will be described later in the results, additional areas were added to the final results based on the species data.

3.2 Setting Targets

The overall goal of the City of Cape Town for biodiversity is to:

- Ensure the conservation and enhancement of the unique biodiversity within its area
- Integrate biodiversity considerations into planning and management, of development in the City of Cape Town
- Ensure the equitable access to biodiversity and nature for all communities
- The social upliftment and economic development of Cape Town's communities through the conservation and enhancement of biodiversity

It was within these broad overarching goals of the City's Biodiversity Strategy that the targets for the analysis were set. The conservation planning analysis set targets and criteria that, if met, would ensure the conservation of the pattern of biodiversity (vegetation types occurring within Cape Town) and process of biodiversity (hydrological and pedological processes) within a network of natural areas.

Various guidelines for conservation targets exist, none of which are absolute (the IUCN's 10% minimum target) and none of which fit all types of ecosystems and habitats. As such the conservation targets for Cape Town were set in a consultative manner at a workshop and in discussions with a range of knowledgeable individuals. The workshop invitees comprised authorities (officials of the City of Cape Town), and specialists (mainly biological and planning specialists, with some social specialists) all with expertise in the Cape Town area. The overriding theme and target during the workshop was to target the minimum set of areas that would hold a representative set of all the unique species and biodiversity (including habitat) in Cape Town and provide the opportunity for long-term survival.

The targets set can be divided into two broad categories, namely pattern of biodiversity and process of biodiversity.

3.2.1 Pattern of Biodiversity

Pattern of biodiversity refers to habitats, communities and ecosystems. In other words, the survival of individual elements of biodiversity, the specie, is dependent on:

- Habitat (its specific living environment, for example certain plants will only grow in specific conditions),
- The biological community (for example certain plants are dependent on certain birds for pollination. If the birds were removed from the environment the plant would not survive either)
- The overall ecosystem, this is the much larger overall system that each individual piece of the puzzle makes. An example here is that many of the plant species within Cape Town are dependent on fire for their lifecycles. If fire was removed or stopped permanently, the ecosystem would be affected and by consequence the life cycles of individual plants would be threatened.

In summary, pattern of biodiversity is the various inter linked levels – the specific living environment for each specie, how that specie is dependent on and forms part of the biological community and how all of these levels interlink into a functional ecosystem – that are dependent on each other for the overall survival of biodiversity. A major disruption or loss of one of these levels will have ramifications and spin off effects for all the other levels and individuals within the system.

The targets for conservation of pattern were determined on rarity and the degree of transformation of vegetation communities. In other words, how rare is the vegetation community within the study area and to what degree has the vegetation community been transformed from its original extent prior to development and growth of the city.

An initial or broad base target was set for each of the vegetation communities. This was done as a starting point using three basic classes defined by original extent of the vegetation type - the more limited the original extent, the higher the base target. In other words if a vegetation community only ever occurred in an area of 50km^2 within the entire study area it was given a higher base target of conserving 20% of that area as opposed to a vegetation community that occurred over 400km^2 which was given a base target of 10%. A third category of 15% was used as a base target for intermediate vegetation communities. The final target was then determined by altering these initial base targets by the degree of transformation. For example, if a vegetation community was originally widespread, e.g. covered over 500km^2 of the study area, but development and transformation had severely impacted on that particular vegetation community, i.e. its degree of transformation was high, then the base target needed to be elevated. Looking at the calculations, if the vegetation community originally extended over 500km^2 the base target would be 10% or 50km^2 as an area for conservation. However if the degree of transformation for that particular vegetation community had been high, for example of the original 500km^2, 300km^2 had fallen under development of houses, then the base target needed to be elevated as the original 10% target of the now remaining 200km^2 (500 – 300 transformed) would be an insufficient 20km^2. This degree of transformation was calculated using the equation

$$t = 2 - ce/he$$

where (t) equals the degree of transformation, (ce) is the current extent in km^2 and (he) the historical extent in km^2.

Using the example above, the original extent of the vegetation community was 500km^2, the current or remaining extent is 200km^2 (300km^2 having been transformed), the degree of transformation or transformation value is therefore 2 - 0,4 which equals 1,6, a high degree of transformation. The final targets for each vegetation community were then calculated by multiplying the original base target by the degree of transformation. Again, using the example above, the original 500km^2 extent of the vegetation community gave it a relatively low base target of 10%. However, this same vegetation community had been highly transformed through development and only 200km^2 of the original 500km^2 remained. The final target for the vegetation type is calculated by multiplying the original base target of 10% by the degree of transformation, in this case 1,6, so in this example that would be 10% X 1,6 which gives a final target of **16% of the original extent of the vegetation community**. In other words, the conservation target is set on the original extent of the vegetation community and not what remains. So again, using the example above, 16% of the original 500km^2 must be conserved to meet minimum targets. In this case 200km^2 remain, and 16% of 500km^2 is equal to 80km^2, therefore 80km^2 of the remaining 200km^2 must be conserved to meet the conservation targets for that vegetation community.

In some cases where the degree of transformation is so high, the targets can never be met. For example, the vegetation community *West Coast Renosterveld on shale* which is listed as critical had an original extent of 469km^2. Due to the relatively large original extent the base target was set at 10%. However, this particular vegetation type has been severely transformed and only 46km^2 remain. The transformation index is therefore very high at 1,9 and the final target is therefore set at 19% of the original 469km^2. This gives a minimum target of 89,1km^2 that must be protected to meet conservation goals. However, only 46km^2 remain, therefore it is critical and a priority that 100% of the remaining 46km^2 are protected and conserved.

In summary, the final targets for the 14 vegetation types used varied from between 14% and 31% of the original extent of vegetation types. However for three vegetation types, the degree of transformation has been so severe that remaining available areas is less than the target. The table below gives the targets for each vegetation type

Vegetation Type	Historical Extent	Remaining extent	Extent Transformed %	Base Target %	Final Target %	Target in km^2	Percentage of remaining that must be conserved
Wsh	469,3	46,1	90,2	10	19	89,26	100%
Wg	74,5	18,5	75,1	16	28	20,87	100 %
Wq	0,3	0,3	0	20	20	0,07	23%
Dc	356,7	136,5	61,7	13	21,03	74,99	54.9%
Dl	53	31,6	40,4	16	22,4	11,88	37.6%
DS	95,6	95,4	0,2	16	16,03	15,33	16%
Si	94,9	11,6	87,8	16	30,1	28,52	100%
Sm	630,7	123	80,5	10	18,1	113,84	92.5%
Sq	232,9	58,1	75	13	22,8	52,98	91.2%
Mq	5,9	5,8	1,3	20	20,3	1,19	20.5%
Mgk	3,4	1,5	55,4	20	31,1	1,05	70%
Ms	358,7	330,3	7,9	13	14	50,32	15.2%
Mshm	9,8	8,2	16,1	20	23,22	2,27	27.7%
Mg	69	29	58,1	16	25,3	17,46	60.2%

For species data, the targets were set based on the number of known locations for each species. For species, two databases were used to set the targets and do the analysis. The Protea Atlas Project and the Sites and Species Databases were used, and the targets were set as the following:

- For all species with five or less known locations the target was set at 100% of known locations. In other words, all five or less locations must be achieved in the result.
- For species with six or more known locations the target was set at 80% of known locations, in other words at least 80% of known locations must be achieved in the results.

For freshwater aquatic systems, which includes rivers, vleis and wetlands the target was set at 100% of all rivers, vleis and wetlands within the City. The reason for this was the value attributed to these systems not only for their importance of biological diversity but also for their importance as modes and means of connectivity as well as the critical environmental service healthy aquatic systems play within a city in water supply, flood attenuation and recreation.

3.2.2 Biodiversity Process

Setting and achieving targets for maximising biodiversity process is extremely important but a far more complex challenge. Process occurs at a range of levels, from the micro (within a very small area) to the macro (where process occurs across the landscape – for example the movement of windblown sand across the peninsula). In the most, simple form, process is enhanced and maintained through connectivity across the landscape. Two distinct approaches were used in terms of process.

Firstly, in terms of targets, process was considered to be conserved at the micro level through the attainment of pattern targets. In other words process at the smallest level will be captured within areas identified through the pattern targets. In addition, by applying the principles of biogeography in the analysis by selecting largest areas first and prioritising connectivity in the selection, process is captured. Finally, the 100% selection of all river systems will help capture process at a macro level across the landscape.

Secondly, a friction analysis was undertaken to identify and define spatial corridors across the city which would provide the most efficient and least resistant biological opportunity, biological movement and the maintenance of process. The method and detail of the friction analysis is discussed in Section 3.4 below.

In terms of process it is important to note that within an altered and urban landscape it would be impossible to conserve and protect process completely and at all levels. By its very nature, development and urban sprawl interrupts, impacts, changes and effects natural process. This analysis approached the critical aspect of process from a point of maximising and enhancing process through the following key points:

- Selecting largest remnant areas first
- Selecting remnant areas within closest proximity to other remnant areas
- Selecting all rivers, vleis and wetlands
- Identifying the efficient path of least resistance across the city through a friction analysis (Section 3.4)

3.3 Criteria for selection of areas to meet the targets and the analysis

3.3.1 Criteria

Now that the targets for each of the 14 vegetation types have been set and the principles for maintaining process derived, a set of criteria for selection of sites into the final outcome network must be established. Section 2.5 discussed these criteria in detail and the rationale for their use, however it is worth recapping the criteria now that targets have been explained.

In summary, a set of ranked or ordered choices are used to identify the sites to be included in the network from the suit of available sites. For three of the vegetation types and for all rivers, vleis and wetlands, the choice is 100% of all that remain in the City. The three vegetation types are those that not enough remaining areas exist to meet the set targets and therefore all that remains must be captured as a minimum. For the other 11 vegetation types however, more available areas remain than is needed to meet the targets and therefore a set of criteria for making the choice of which areas should be included is needed. These criteria or set of choices are also ranked in order of importance. In other words, the analysis works like a decision tree. The most highly ranked criteria or choice is applied first and all areas that meet the criteria are selected. All remaining areas are then assessed according to the next choice and so on. These set of criteria or choices are known as the biological planning criteria and are listed below in their ranking as applied in the analysis:

1) Irreplaceability: Areas of highest conservation priority chosen first
2) Size: A cut off of 10 hectares was chosen. In other words, largest sites were chosen first. This issue of size in the Cape Floristic Kingdom is a contentious one as ecologically it is known that very small sites can be critically important in maintaining both pattern and process. However, size criteria was deemed important from a pragmatic and realistic approach to conservation within an urban area
3) Complimentarity: Linked closely to irreplaceability, this is one of the core principles of conservation planning and in simple terms it is the selection of sites that have the greatest diversity of vegetation types and species. In other words, sites that compliment each other in terms of maximising the number of species and vegetation types captured.
4) Connectivity: Fundamentally to maintain process and enhance biological opportunity, proximity of one site to another is prioritised over sites that are distant from each other.

3.3.2 The Analysis

The analysis was done using Arcview and the add-on programme C-Plan. Arcview is a Geographic Information System and C-Plan is a conservation planning tool. In simple terms, the data, targets, and criteria are input into the spatial GIS system and the computer model runs a number of iterations and selects the sites and areas from those that are available to meet the minimum targets using the criteria (set of choices) as described above.

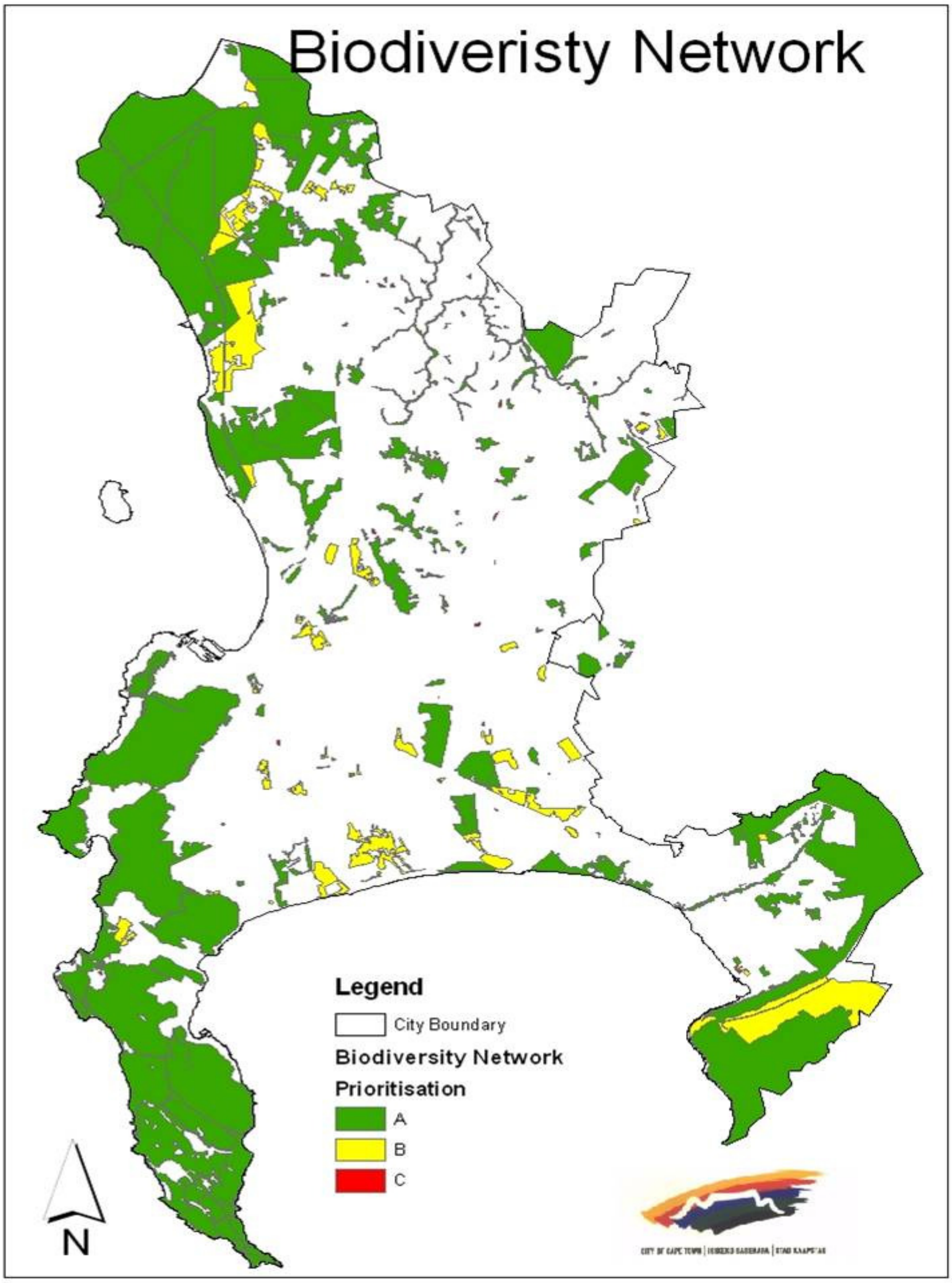

Figure One: Results of the analysis

3.4 Spatially explicit process: A Friction analysis

A friction analysis was undertaken once the selection of sites had been completed. This analysis involved developing a friction model of all the selected sites, the existing nature reserves and the Core Flora sites in relation to all other features such as rivers, and other land use patterns such as agricultural land, roads, built areas etc. The friction model works in the following way; each land use is assessed according to its compatibility with conservation of biodiversity. This assessment provides an individual score for each land use type. Those that are most compatible with conservation are given a low score, for example selected sites, Core Flora sites and existing nature reserves receive a friction value of 1. Dams, wastewater treatment works water bodies received a friction score of 5, low intensity agriculture a score of 60, high intensity agriculture a score of 120 and industrial areas and settlements a score of 240. The friction model is run and the model is asked to find the path of least friction (or resistance) from point A to point B (point A being a biodiversity area and B another biodiversity area across the landscape). The model chooses the areas with the lowest scores in finding the most efficient and effective path from A to B. The results from the friction analysis provide a planning framework for biological flow and opportunity across the city's landscape and identifies pathways to connect critical ecosystems (mountains to mountains or coast to coast) across the City. Effectively these corridors or pathways optimise routes between natural areas by selecting areas or pathways containing natural vegetation and major vegetation types. This approach allows the conservation planning process to look at the spatial viability of each selected site in relation to all the other selected sites.

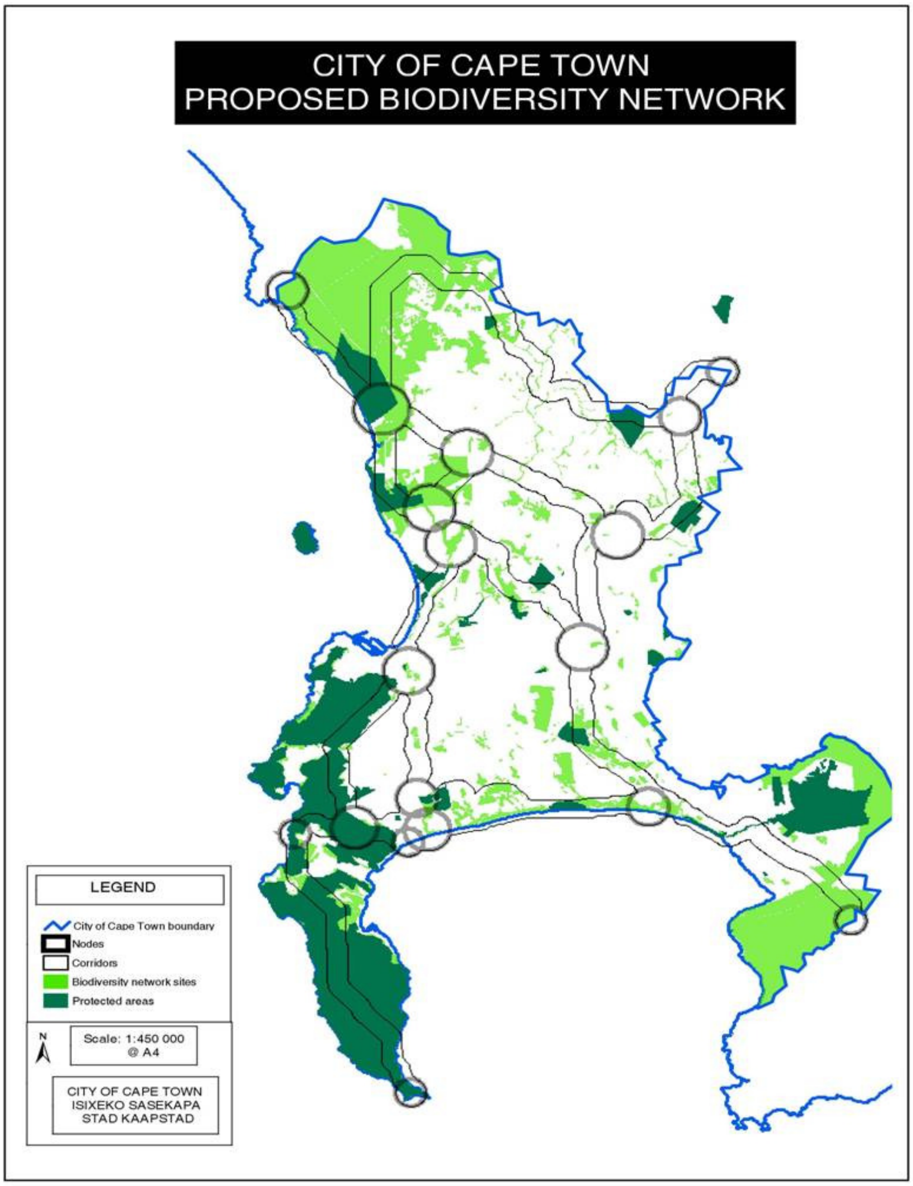

Figure Two: Biodiversity Network with corridors

3.5 Results from the analysis

In summary 219 sites or areas were selected to meet the targets set for the 14 vegetation types. It is important to note that for 3 of the vegetation types, namely Sand Plain Fynnbos on inland older non marine derived acid sands (Si), west coast renosterveld on shale (Wsh) and west coast renosterveld on granite (Wg), the targets could not be met. A further 42 areas were selected to meet the floral species targets for the Protea Atlas and Site and Species Databases. The total number of sites or areas selected to meet the minimum targets set (using both vegetation data and species data) was a total of 261 sites or 32 262 ha.

These 261 sites or 32 262 ha of natural remnants are needed in addition to the existing nature reserves, all the rivers, vleis and wetlands, and the 37 Core Flora Sites to enhance and protect a minimum representative and sustainable set of all of the unique biodiversity in the City of Cape Town.

The friction model identified 19 biological pathways or corridors that efficiently and effectively interlink the network of natural areas and connect major ecological systems across the landscape (mountain to mountain and coast to coast).

4. IMPLEMENTATION MODEL

4.1 Implementation in an urban setting

Having identified the minimum network, the focus must now shift towards a framework for implementation and attainment of the natural area network within a developing urban context. As depicted in the results, a total of 261 natural areas are required totalling 32262 ha to meet the targets. This represents a significant portion of remaining open space within the City. As such it is important at this point to revisit the urban context and its competing needs in terms of human settlement and economic growth, and in Cape Town's context, the express need for social upliftment and enhancement of human living environments. Cape Town's population is approximately 3,2 million people growing at a rate of 3% per annum. Of the current 3,2 million people, 0,6 million live in informal settlements with little or no basic services. Unemployment levels are 30% and poverty is a major factor for many people in the metro. Large sections of the populations have limited or no access to quality open space for recreation and impoverished areas are environmentally poor. This translates into an urban setting for which the priorities must be to develop housing, grow economically and provide a range of social services and infrastructure. This means more road networks, wastewater treatment works, housing developments, economic centres, commercial and retail centres and schools. All of these require space and therefore on the surface it would appear that the much needed economic development and social upliftment of the city is in direct conflict and competition with the areas needed for the maintenance and conservation of biodiversity. How does a network of an additional 261 natural areas fit into a City with so many priorities and competing demands? It is this issue of multiple needs within the urban development context that in itself sets the implementation framework.

Firstly it is neither, realistic or practical, from a resource perspective (financial and capacity) to suggest a further 261 nature reserves within the metropolitan area. Nor are a further 261 nature reserves desirable from a land use perspective within an urban context where multiple land use types are needed to meet social and economic needs. Using this as a point of departure, is there then opportunity to integrate biodiversity conservation, and the targets set, into the urban fabric and promote a paradigm that development and conservation of biodiversity are not mutually exclusive but rather mutually beneficial? This concept of integration of natural systems within development underpins sustainable development concepts and as a broad framework, forms the basis for an implementation plan or mechanism for the successful attainment of the 261 identified areas and by implication, the targets set for biodiversity. For this implementation framework to take shape a number of key concepts and principles need to be developed and applied to the network as decision-making tools.

4.2 Concepts and Principles

Historically conservation areas, or areas that perform a conservation function, have been considered exclusive restricted areas that allow little or no other land use type or activity within the area. This historical approach has been slowly changing with a greater recognition nationally and internationally that conservation areas, must and can, play a much greater role in providing a range of social and human needs. As such, the concept of integrated mixed use areas has evolved. However within this new approach of multiple and mixed use areas, the concept of core areas set aside purely for conservation must remain as the anchors, nodes or focal points for conservation. This translates into a workable system of core conservation areas supported and in support of a number of mixed use areas that provide a biodiversity function within a multiple use framework. The ability of this approach to function effectively is further enhanced by a set of corridors and links between the mixed use areas and the core areas providing the important connectivity and maintenance of process that is so crucial to the long term sustainability of biodiversity. Emerging from this rationale are a number of key concepts including; core conservation areas, mixed use areas, anchors or focal points within this network of core and mixed use areas and finally interlinking and connecting this network to enhance and encourage biological opportunity and biological process.

These concepts are expanded on below followed by the methodology and mechanism for applying them as decision tools to the network identified in the analysis.

4.2.1 Core conservation areas and mixed use areas

To best frame a network consisting of core conservation areas and mixed use or multi functional areas, an expansion on each of these terms is needed. Within this approach to conservation of biodiversity in Cape Town:

- A core conservation site is considered as an area which is legally defined with the appropriate conservation status and managed and maintained in the long term for the primary purpose of conserving biodiversity (pattern and process). The area would exclude land use types and activities that would negatively impact on the core function or biodiversity conservation and its ability to be sustained in the long term. Appropriate activities that may be included within the area would be those that assist in and contribute to conservation or provide opportunity for people to be exposed to nature and biodiversity. Examples of this include environmental education and youth development centres and programmes, eco-activities such as hiking, bird watching and limited overnight accommodation, and economic opportunities such as eco-tourism through guiding and tours. Limited natural resource use and harvesting may occur but this must be developed and defined within the constraints of the site-specific management plan and carrying capacity. <u>Within the conservation framework these core conservation areas have been termed Category A biodiversity sites</u>
- Mixed use or multifunctional conservation areas are those areas that have a significant role to play in conserving biodiversity both in the long term and sustainably, but which also provide opportunity for other appropriate land use types and activities. Clearly within this framework of mixed use areas there is a range of approaches that may be adopted and a range of scales of mixed and multiple-use. <u>To allow for easier and more efficient decision making, this broad category of mixed use areas has been further divided into two sub categories, Category B biodiversity sites and Category C biodiversity sites.</u>
- Category B sites are those that are managed for biodiversity but which may support a range of activities and land use types not normally associated with conservation areas. Examples of this may include open spaces where people can walk their dogs, limited development of part of the site such as a green housing development or other infrastructure such as a wastewater treatment works. The overall principle is that the site must be managed primarily for biodiversity but must allow other land use types and activities that are not overly detrimental to the principles of conservation
- Category C sites are those that are primarily managed for other land use types and activities but which through integrated management and the principles of sustainable development also play a significant role in the conservation of biodiversity. Examples of Category C sites may include parks and recreation areas, road verges and islands, servitudes, golf courses (within the correct context), housing developments, low intensity agricultural areas and commercial development.

Central to this approach is to develop a clear methodology with sound logic and approach that when applied to the network would select from the 261 sites those that should be categorised as A sites, those that would best suit B sites and finally those that would be C sites. This methodology for identifying A, B and C sites – using the principles of ireplaceability – is in fact a methodology to prioritise the network into A, B and C. At this point it may seem contrary to, and undermining of, the original methodology to suggest that the network, which represents the minimum number of sites for conservation of biodiversity now be further prioritised. Some may argue that you cannot prioritise a network that in itself represents the absolute minimum (which by definition means that all of the sites are already priorities). What needs to be made clear at this point, is that by further prioritisation of the network, the principle is around integration of biodiversity into an urban environment rather than suggesting a lower importance of certain sites over others. In other words the prioritisation is a mechanism for implementation, which involves a degree of compromise on historic conservation principles, but positively looks towards integrating nature into the urban living environment.

In addition, particularly as it relates to B and C sites, very clear and defined land use guidelines are needed to ensure that the underlying principles of conservation of biodiversity are secured for each of those categories as part of the development of land use types and activities not directly related to conservation or which do not directly contribute to conservation.

4.2.2 Anchors or nodes

Anchors or biodiversity nodes in the network are a concept that presents focal points of biodiversity conservation as well as the range of services that large well managed and well resourced conservation areas can provide too the communities of Cape Town. The concept of the biodiversity node or anchor is two fold, firstly biological and secondly socio economic.

From a biological or conservation perspective biodiversity nodes are large areas that are well resourced and managed to a high standard. They act as the pool or source of biodiversity that can continue to populate outlying areas and maintain biodiversity flows. Another way of describing them is biodiversity refuges, safe places where biodiversity can flourish with interventions to remove undue human induced pressures and impacts. Biodiversity nodes will fulfil the function of maintaining ecological processes at the landscape level and mitigate against the physical pressures associated with urban development for biodiversity at the city-wide scale.

From a socio economic perspective, biodiversity nodes are the flagships of nature areas within Cape Town. Due to their size and standard of management they provide significant opportunity for tourism and nature recreation, education and capacity building as well as visual and aesthetic value within the landscape.

Examples of existing areas that fit within the concept of biodiversity nodes within the proposed network are Blaauwberg Conservation Area, False Bay Ecology Park and of course Table Mountain National Park.

Within these definitions biodiversity nodes can be discrete large contiguous areas, a collection of smaller areas within close proximity of each other, or a combination of large and small areas clumped together. Within the clumped scenario, the biodiversity node may even be made up of Categories A, B and C, although category A areas must be present. This approach also allows for a very pragmatic institutional management perspective, allowing for a “clump” of areas to be managed as one management unit.

4.2.3 Corridors or pathways

A biodiversity corridor or pathway should provide for the movement of species along and between ecosystems, thus allowing species to complete their life cycles, move away from adverse environmental change, dispersal of offspring and seeds, for feeding and colonisation. Biological corridors or pathways are non-discrete, in other words they do not have a specific edge or spatial boundary but are more conceptual by focussing on creating opportunity for movement through undisturbed areas, stepping stones or linear river systems (which by their nature are corridors). An example of a corridor within an urban setting is a number of private gardens between two urban conservation areas. The gardens themselves have no formal conservation status but when viewed as a single system between the two urban areas, they have significant potential, if managed and maintained in a way that promotes biological opportunity, to act as a biological corridor between the conservation areas. This example may be expanded to include road verges and centre islands, river systems and walkways/cycle routes that together may provide opportunity of movement and transport of species and organisms between two conservation areas. Another key example of a pathway or corridor in Cape Town is the coast line. In essence corridors or pathways are the key factors in connecting and interlinking the naturalness of the City, creating opportunity and maintaining the entire urban area as a single living healthy entity.

In terms of identifying and defining corridors we therefore need to shift from spatially exact and defined areas to spatially conceptual ideas where management and maintenance begin to play a greater role in defining corridors. A broad framework for identifying linkages and most efficient flows is needed. This framework was identified during the friction analysis described in Chapter 3 and the challenge is now to focus on conceptual and management considerations to optimise those flows.

Corridors or pathways also provide social and economic opportunity through creating opportunity for people to recreate and move through greenbelts within a highly urban area (cycle routes, walking paths etc).

Corridors and pathways already exist within the City, the key is to apply key management and maintenance principles to those areas identified within the broad corridor framework at a city wide scale (friction analysis) and at a localised planning level between urban natural areas. These key management and maintenance principles include:

- Promotion and use of natural indigenous vegetation on both private and public land
- Planning development within an integrated manner that includes connectivity between natural spaces
- The management of riverine areas, both the buffer zone or flood plain around the river as well as the water quality within the river
- Management and maintenance of catchments
- Promoting the concept of corridors and conservation ethic to private land owners
- Viewing all open space as opportunity to contribute to connectivity, a living environment and biological opportunity (e.g. servitudes, powerlines, stormwater drains, pavements and road verges)

4.3 Applying key implementation principles to the Network: Methodology

Having detailed the principles and concepts that are integral to an effective and realised biodiversity network, these principles and concepts must now be applied to the network. This is done in a stepped approach, with a defined methodology for each step. The stepped approach includes:

- Scoring each of the areas identified within the network as either Category A, B or C. In this analysis, areas with current protective status and the Core Flora sites are included in the prioritisation as A sites.
- Score each river reach and wetland as Category A, B or C
- From the prioritised biodiversity network, identify and define a set of biodiversity nodes or anchors
- Overlay the biodiversity corridor framework (from the friction analysis) onto the prioritised biodiversity network identifying key movement efficiencies and pathways
- Define appropriate land use guidelines for category A, B and C that must guide and direct future development within those categories

4.3.1 Prioritisation of terrestrial areas and rivers and wetlands into Categories A, B and C

To prioritise the terrestrial network areas into the three categories a set of choices or criteria were developed and then applied to each site one at a time. In other words, each site and its individual characteristics were measured against a hierarchical set of rules, if the site met any one of the rules it was categorised accordingly. This is known as a decision tree. The decision tree and the explanation for each of the rules is detailed below.

Rule1. Is the natural area currently a formally protected area or one of the Core Flora Sites? If so, the area is categorised as an A. In other words, all existing protected areas and nature reserves as well as the 37 Core Flora sits identified in 1997 are prioritised as category A areas.

If the site does not meet any of the choices in Rule 1, then move to Rule 2.

Rule 2. Does the site contain more than 5% of the extant distribution of one of the three critical vegetation types? If so, the area is categorised as an A. In other words, from the conservation analysis, three of the vegetation types have been so transformed that the targets set could never be met. Therefore any area that contains more than 5% of what remains of those three vegetation types is of critical importance and is therefore prioritised as an A. 5% was defined as a cut off level as a pragmatic management consideration.

If the site does not meet any of the choices or criteria of Rule 2, then move to Rule 3.

Rule 3. Is the site greater than 10ha in size AND has an irreplaceability value of greater than or equal to 0,9? If so, the area is categorised as an A. In other words all large areas of the highest conservation priority (irreplaceability) are chosen as category A sites.

If the site does not meet any of the choices or criteria for Rule 3, then move to Rule 4.

Rule 4. Its it a wetland of high or very high importance class or a river reach of extreme or high ecological priority (as defined by the Ecological Importance and Sensitivity Assessment done in the River and Vlei Assessment and Monitoring in the CMA study)? If so the river reach or wetland is categorised as an A. In other words, all important wetlands are captured as A while parts or reaches of rivers that are of extreme or high ecological priority are given A status.

If the site does not meet any of the choices or criteria for Rule 4, then move to Rule 5.

Rule 5. Does the site have an irreplaceability value of greater than or equal to 0,75 but less than 0,9 and is greater than 10ha in size? If so, the site is an A. This rule compliments Rule 3.

Rule 6. Does the site have an irreplaceability of between 0,75 and 0,9 but is less than 10ha in size? If so then it is categorised as a B. In other words, all those sites that did not meet the size cut off in Rule 5, but which have a conservation importance of greater than or equal to 0,75 are categorised as B areas.

If the site does not meet any of the choices or criteria for Rule 6, then move to Rule 7.

Rule 7. Does the site have an irreplaceability of less than 0,75 but is greater in size than 5ha? If so, the site is a B. In other words larger sites that have lower ireplaceability scores are categorised as B sites. In addition, all wetlands that are classed as moderate importance, or river reaches of moderate ecological priority (as defined in the Ecological Importance and Sensitivity Assessment done in the River and Vlei Assessment and Monitoring in the CMA study) are categorised as B's.

Rule 8. All remaining terrestrial sites and wetlands and river reaches are categorised as Category C.

4.3.2 Results of the prioritisation

The results from the prioritisation of the network into categories A, B and C are presented in the table for terrestrial areas.

Prioritisation Category	Total number of Biodiversity Areas selected	Total Area (ha)	Largest Biodiversity Area (ha)	Smallest Biodiversity Area (ha)
A	228	76848	12693	0.3
B	46	6327	1328	12.0
C	95	314	9	0.3

Of the 228 areas selected as A, 108 are either existing reserves or Core Flora sites.

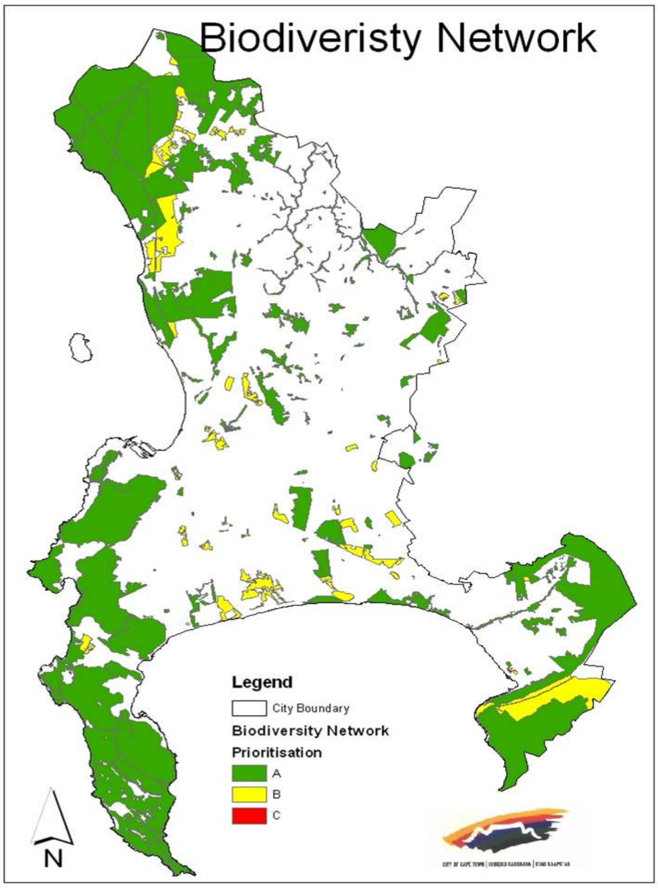

Figure Three: Prioritised Network

The results from the prioritisation of all the wetlands into categories A, B and C are presented in the table below.

Wetland name	Classification	Water Catchment	EIS (Wetland Ecological Importance and Sensitivity Class)	Biodiversity Network Prioritisation Category
Rietvlei	Vlei	Diep River	A	A
Blouvlei	Vlei	Diep River	A	A
Zoarvlei	Vlei	Diep River	C	B
Door de Kraal	Detention pond	Salt River	No EIS rating given	-
Fynbos Dam	Dam (urban wetland)	Salt River	No EIS rating given	-
Amandal Dam	Dam (urban wetland)	Salt River	C	B
Kreupelboom Dam	Dam (urban wetland)	Salt River	C	B
Kannonberg Dam	Dam (urban wetlands)	Salt River	No EIS rating given	-
Princessvlei	Vlei	Zeekoevlei	C	B

Little Princessvlei	Vlei	Sand River	C	B
Langevlei	Vlei	Sand River	C	B
Rondevlei	Vlei	Zeekoevlei	A	A
Zeekoevlei	Vlei	Zeekoevlei	C	B
Zandvlei	Vlei	Sand River	B	A
Lake Michelle	Vlei (excavated salt pan)	Noordhoek Wetlands	B	A
Pick 'n Pay Reedbeds	Wetland	Noordhoek Wetlands	C	B
Wildevoelvlei	Vlei	Noordhoek Wetlands	No EIS rating given	-
Westlake	Wetland	Sand River	B	A

The Table below presents the results of the prioritisation analysis for rivers in the City of Cape Town. The table presents a summary of the analysis results, showing the length of river reach classified into categories A, B and C.

Prioritisation Category	Total length of river selected (km)	% of total river length
A	391.7	47.4
B	328.6	39.8
C	105.3	12.8

It must be noted that due to the significant ecological, social and economic value of freshwater systems in urban areas, all freshwater systems should be protected.

4.3.3 Methodology for identifying biodiversity nodes

The identification of areas or clumps of areas to be assigned as biodiversity nodes or anchors within the network was driven by three key aspects:

- Biodiversity conservation function, in other words maintenance of biodiversity pattern and process
- Socio economic, in other words the contribution to social and economic functions and opportunities
- Management practicalities, in other words the most efficient and effective use of limited and constrained management resources (both management and staff capacity as well as operating financial costs)

Again a decision tree was developed consisting of a number of choices and criteria against which the entire network of areas would be applied.

Rule 1: Is it a large protected area/NHR/wetland greater than 100 hectares?
YES? - becomes a node or part of a node
NO? - go to rule two
One larger area is easier to manage compared with many small areas and large areas provide greater opportunity for a range of social and economic benefits as opposed to a number of small areas.

Rule 2: Are there several protected areas/biodiversity areas/wetlands adjacent and physically connected that have a summed area of greater than 100 hectares?
YES? – Combined these areas form a node
NO? - go to Rule 4

Rule 3: There are nodes (identified in 1 or 2 above) that are closer than 1 km to each other?
Yes? – these nodes are combined into a single large node
No? – these remain as individual nodes

Rule 4: There are protected areas/biodiversity areas/wetlands that are closer than 1 km to a node identified in 1, 2 or 3 above?

YES? – these areas become part of the node
NO? - go to Rule 5

Rule 5: Is there an Environmental Education Centre or proposals for Environmental Education Centre or an active Environmental Education/conservation-related youth development curriculum that uses the protected area/biodiversity area/wetland?

YES? - becomes a node
NO? - will not become a node

Beyond the application of the decision tree above, the project team provided a further rationalisation of the node selection. For example, the Drifsands/Khayelitsha node and the Wolfgat/Macassar nodes were initially combined as one node by the analysis. On review, it was recommended that these be separated into two distinct nodes in terms of management practicality.

4.3.4 Results of node identification

Eight biodiversity nodes/anchor points were identified and are presented in the map below. The following tentative names have been assigned to identify the nodes.

1. Wolfgat/Macassar Dunes
2. North West/Diep River
3. Blaauwberg
4. Joostenberg
5. Tygerberg
6. Driftsands/Khayelitsha
7. Helderberg/Kogelberg
8. Zeekoeivlei/Pelican Park
9. Cape Peninsula (including the TMNP)

4.3.5 Corridors and pathways

As was described and discussed in Section 3, a set of corridors and pathways that represent the most efficient and effective routes of movement across the City at the macro scale, from coast to coast and mountain to mountain, were identified through a friction analysis. This set of pathways is depicted in figure two in section three.

These corridors represent the broad framework at the macro scale and should guide the realisation of the conceptual approach to a single interlinked set of natural areas providing biological opportunity and connectivity across the city. The focus should be on realising a healthy living environment that promotes and maintains natural systems, patterns and process.

However, the realisation of this broad framework will be achieved at the localised or micro level, where pathways and corridors between two points are identified through local planning and spatial development frameworks. In addition, corridors and pathways and their implementation are fundamentally a conceptual and principled approach and as such much will be realised through public education and awareness as well as integration with the Metropolitan Open Space System, the management of catchments within the city, the management of parks, amenities, sport and recreation, and road and transport networks.

4.3.6 Final Biodiversity Network

The final Biodiversity Network is comprised of the following elements:

- The minimum set of areas needed to meet the City's biodiversity targets. In other words the minimum suit of areas that together will conserve a minimum set of the full range of biodiversity in Cape Town

- The prioritisation of all of the identified areas into Category A, B and C which is the mechanism for implementation of the network within an urban context that has multiple social and economic needs and pressures
- The identified Biodiversity Nodes that will provide the core anchors of the network and be the flag ships of biodiversity conservation in the metropolitan area
- The framework for biodiversity corridors, pathways and flows that give direction and guidance for the establishment of corridors at the macro scale. It must be noted that corridors and pathways at the micro scale will be identified during localised implementation of the network.

5. MANAGEMENT MODELS AND LANDUSE GUIDELINES

Introduction

Now that a functional biodiversity network consisting of a set of minimum areas categorised into A, B and C priorities with biodiversity nodal points anchoring the system and interlinked through a framework of corridors and pathways has been identified, land use guidelines and a range of management models need to be defined that may be applied to the network. These land use guidelines and management models are the "how" of the network and should present a range of suitable options for ensuring that each part of the network is managed and/or developed in such a way that its intended contribution to the overall conservation of biodiversity by the network is ensured and realised.

Understanding that the network now consists of areas that should be conserved as formal nature reserves, areas that may be developed within limited constraints and areas that may be developed to a certain degree; a suitable suit of management models and land use guidelines are needed. These planning or land use guidelines introduce the Biodiversity Network into Cape Town's development planning system as well as incorporate Biodiversity Network considerations into land use management systems.

Secondly this section identifies the range of conservation management models that may be applied to realise both the conservation status of the area or the partial development as defined by the land use guidelines.

Finally this section discusses management and other considerations for open space areas that fall outside of the identified network and whose critical biodiversity value may only come to the fore following various onsite inspections and surveys thus warranting inclusion into the network.

5.1 Land Use Guidelines

Having designated each biodiversity/natural area as either an A, B or C, it is now imperative the clear land use guidelines be developed to frame and guide appropriate development and land use within each category. The intention of the land use guidelines is to create an opportunity for the local authority to work with developers and individuals to create a positive situation whereby appropriate development is encouraged and supported while biodiversity targets and principles are maintained.

While applying and using these guidelines it must be noted that these guidelines aim to give direction and guidance and that contextual studies to ascertain how surrounding land uses impact on biodiversity (i.e. an area's vulnerability to various threats) have not been considered in the prioritisation of the overall network. Undoubtedly contextual inputs have a bearing on the prospects of achieving conservation targets and the specifics of compatible land uses within different parts of the network. Contextual inputs need to be factored in on a site-specific basis and will give rise to detailed land use guidelines for specific components of the network.

As a reminder, Category A areas are those that should be afforded the highest conservation status as there are limited alternative areas within the City's borders, and specifically within the identified Biodiversity Network that meet conservation targets. Category B areas also warrant being managed for biodiversity conservation purposes, but compared to Category A there are more alternative sites within the network that meet conservation targets. Category C areas also warrant being managed for biodiversity conservation purposes, but compared to Categories A and B there are significantly more alternative areas within the city that meet conservation targets. Hence, B and C areas provide greater opportunity and flexibility in the kinds and types of development that would be appropriate.

Therefore in broad terms the following guidelines are relevant:

- Category A areas should be used exclusively for biodiversity conservation purposes,
- Category B areas should be used primarily for biodiversity conservation purposes, but can also accommodate other compatible land uses, and

- Category C areas should also be used for biodiversity conservation purposes, but this will not be their primary use.

5.1.1 Category A Areas

The following broad guidelines should be applied to all Category A areas:

- Restore/maintain as natural landscapes, and prevent land uses that transform these qualities
- Avoid motorized access and control access on foot.
- Maintain wild, remote and wilderness experiential qualities (practically, this will not be possible in all instances of category A sites, probably at only in the largest sites)
- Promote consolidation of the conservation estate and prohibit further fragmentation (i.e. no sub-division).
- Facilitate co-management arrangements between private landowners and conservation authorities.
- Strictly enforce the regulatory framework.
- Limited scope for negotiated agreements, preferable to use fiscal incentives (e.g. rates rebate) where limitations sought on existing land use rights.
- Cluster essential structures and facilities, and locate on the periphery of core conservation areas.

When applying these guidelines to public land, in principle, the City should not support development proposals on Category A public land, especially if the property represents one of the three vegetation types for which conservation targets cannot be met. The City should rather assist the applicant in finding alternative suitable land. Should suitable alternative land not be found and the development of the site is motivated on strategic grounds, the City should seek replacement conservation sites that can contribute to the meeting of its area based biodiversity targets (e.g. possible upgrading of Category B site to Category A). The focus should be to secure the Category A site (and adjacent sites) for conservation purposes and introducing an appropriate management system.

When applying these guidelines to private land, in principle the City should not support any enhancement of development rights on privately owned Category A land. The City should rather investigate means of securing the site for conservation purposes (e.g. through land acquisition, contractual agreements, rates rebates, etc). Where an applicant wishes to exercise existing rights the City should also explore means of securing the site for conservation purposes. Should these prove unfeasible the City should explore with the applicant limited use rights that do not infringe on the conservation integrity of the property. In this regard the Consent Uses listed in the IZS Environmental, Heritage and Open Space base zone could be considered.

5.1.2 Category B:

The following broad guidelines should be applied to all Category B areas:

- Restore/maintain as natural/semi-natural landscapes.
- Where the spatial orientation allows, use the areas as a buffer to Category A areas.
- Limit motorised access should be allowed and manage non-motorised access.
- Promote land consolidation and minimize further sub-divisions.
- Facilitate co-management arrangements between private landowners and conservation authorities.
- Enforce regulatory framework.
- Negotiate agreements with landowners (e.g. transferral of development rights, enhanced development rights at suitable localities in exchange for securing key habitats for conservation purposes, etc), on condition that the conservation worth of the property is not compromised.
- Use fiscal instruments to incentivise biodiversity friendly land uses.

- Consent use for land uses that do not compromise environmental standards, subject to positive EIA and compliance with performance standards.

For both public and privately owned Category B land the City must first check to see if the property is classified in CMOSS as non-negotiable. If it is then the City should not support any development proposals for the site.

Whilst in principle Category B land offers greater flexibility in terms of complimentary uses to its primary biodiversity conservation function, the specifics of suitable complimentary land uses can only be informed by understanding the local context. Socio-economic and spatial considerations thus have a bearing on what is locally appropriate.

Complimentary land uses for Category B land that undermine the City's urban edge policy should not be considered (e.g. no residential development outside the urban edge). The consent uses specified for Category A can be considered here, as well as the additions of hotels and conference facilities, places of entertainment, 4x4 trails, dwelling and guest houses, bio-friendly cultivation and grazing. In all cases consent uses that are approved need to be made subject to the local context, size and operating conditions.

When applying these guidelines to public land, the site should be secured and an appropriate management model identified that gives attention to and promotes complimentary land use that are appropriate in the specific context.

When applying these guidelines to private land, where existing development rights are not in place attention should be given to securing the site through rates rebates, subsidies, etc. The City can also assist the private landowner identify appropriate land use activities for the site. The underlying reasons for the property's inclusion in the Biodiversity Network should be ascertained and complimentary land uses sought that do no impinge on the site's environmental integrity. If the evidence indicates that the site's integrity will not be compromised by the development, at a minimum 60% of existing land area must remain under natural vegetation and all vegetation on the site must be interlinked.

Where development rights do exist, this minimum of remaining interlinked natural areas may be reduced to 50%. Where proposed land uses do impinge on the site's environmental integrity the GIS model should be used to find replacement land. This may include elevating Category C sites to B status, and finding additional C sites from the sites which were not originally selected as part of the Biodiversity Network.

5.1.3 Category C Areas

The following broad guidelines should be applied to all Category C areas:

- Maintain as urban transition zones and prevent intrusion of urban land uses.
- Manage form, coverage and intensity of land use to preserve rural character of landscapes.
- Controlled access with restrictions on motorised access to environmentally sensitive areas.
- Promote land consolidation and discourage further sub-divisions.
- Facilitate co-management arrangements between private landowners and conservation authorities for the maintenance of ecological patterns and processes.
- Enforce regulatory framework.
- Negotiate land use agreements with landowners that result in the protection of the area's significant environmental attributes.
- Use fiscal instruments to incentivise biodiversity friendly land uses.
- Consent use for land uses that do not compromise environmental standards, subject to positive EIA and compliance with performance standards.

For both public and privately owned Category C land the City should first check to see if the property is classified in CMOSS as non-negotiable. If it is then the City should not support the development of the site.

Whilst in principle Category C land offers the greatest flexibility in terms of alternative uses, biodiversity conservation remains an important function here. The specifics of suitable alternative land uses can best be informed by an understanding of the local context. Socio-economic and spatial considerations thus have a bearing on what land uses are appropriate, and these are best identified through local area and sub-regional spatial development frameworks.

Alternative land uses for Category C land that undermine the City's urban edge policy should not be considered. Outside the urban edge attention should be given to controlling the form, coverage and intensity of alternative land uses to preserve the rural character and maintain ecological patterns and processes. The consent use possibilities specified above for Category B can be considered here, as well as institutional facilities, service stations, extractive industries, crematorium, transport facilities, farm stores, commercial kennels and aqua-culture.

If public land the site should be secured and an appropriate management model identified that gives attention to appropriate land use in the specific context.

If private land where existing development rights are not in place attention should be given to ensuring that biodiversity conservation is applied on the property. The City should assist the private landowner identify appropriate land use activities for the site. The underlying reasons for the property's inclusion in the Biodiversity Network should be ascertained and alternative land uses sought that do no impinge on the site's environmental integrity. If the evidence indicates that the site's integrity will not be compromised, a minimum of 50% of existing land area must remain under natural vegetation and all vegetation must by interlinked.

Where development rights do exist, this minimum of natural remaining interlinked areas may be reduced to 30%. Where proposed land uses impinge on the site's environmental integrity, the GIS model should be used to find replacement land. This may include and finding additional Category C sites

Now that broad development guidelines for each category have been defined, the focus must shift towards the mechanisms and tools for implementing these guidelines. This is achieved through the development of a management model for each unique area within its own context. A range of tools are available to achieve these goals and these are outlined and summarised in the next section.

5.2 Management models

A study, Evaluation of Management Models for Protected Areas in the City of Cape Town was undertaken in 2002 (Jackelman and Laros 2002) to identify and evaluate the range of management models that may be used for protected areas in the City of Cape Town. That study identified a number of "tools" which are available for conservation objectives. Management models for each specific area may then be developed by selecting a set of complimentary tools from the "tool kit" which are best suited to the characteristics and complexities of that biodiversity site. These management tools must be used in conjunction with the landuse guidelines detailed in Section 5.1

5.2.1 The Tool Kit

This section summarises all the tools that are available for meeting conservation objectives, and from which a set of best-suited tools can be selected to develop a site-specific conservation management model. These tools are presented under the headings of Legal context, Funding and Management tools.

Legal Context

Conservation Tool Number 1: Land Use Zoning

Local government are able to create land use zones that are specifically devoted to nature conservation, public open space, agriculture and rural landscapes. In other words the City is able to designate land use zones that are restricted to certain land use activities. These land use zones are given effect through the City's Land Use Management System.

Conservation Tool Number 2: Local Authority By-laws

Within the context of national legislation, a local authority may pass by-laws providing that the by-laws are not in conflict with national legislation. By-laws may therefore be sued by the City for example to limit or prevent the removal of indigenous vegetation, and specifically may limit the removal of rare, threatened or endemic species.

Conservation Tool Number 3:.Development approvals

All local authorities are require to take account of environmental impacts of proposed developments before giving development approval. This development approval may be used in conjunction with other tools to ensure that the developer undertakes development in a manner that meets the landuse guidelines described in 5.1.

Conservation Tool Number 4: Trade, Transfer or Enhancement of development rights

Local authorities may use their planning authority and regulation controls of development to facilitate through a trade, transfer or enhancement of existing rights, the change in use of conservation-worthy land within a proposed development area to a use that is consistent with its biodiversity conservation value. An example would be that the City approves development of a portion of a site with the condition that the remaining area be incorporated into a protected area. This is rally a tool for trade-offs.

Conservation Tool Number 5: Land Acquisition

Local authorities may acquire land where there is a willing-seller-willing-buyer case by using land acquisition funds. The acquired land may be managed by the City or another public agency as conservation land or the City may place a covenant on the land and re-sell it. The covenant sets conditions for the new owner and all subsequent owners.

Conservation Tool Number 6: Protected area designation for local government and private land

The City may apply for formal protected area designation for a distinct parcel of land. The benefit of this approach is that it provides a degree of certainty for the conservation status of the land, however the protective area designation places the onus of management and provision of resources on the management authority.

Conservation Tool Number 7: Standard-based legislation for natural resource management

Legislation may provide strong and prescriptive standards and processes against which proposed activities need to be assessed and approved. This standard based legislation is developed by national and provincial government, and allows clear standards and objectives to be articulated and enforced in law. Some of the key standard-based legislation available to the City include:

- National Environmental Management Act
- Environmental Conservation Act
- Biodiversity Act
- Conservation of Agricultural Resources Act

Funding

Conservation Tool Number 8: Funding grants or direct payment to private landowners, individuals or community groups

Local government may provide funding to private landowners, individuals or community groups to undertake conservation work. Binding management agreements or contracts are essential where direct on-going payments are made.

Conservation Tool Number 9: Rates Rebates

A rebate on rates may be provided to landowners who have agreed to manage their land or portions of their land in a conservation manner. A discount on the rates payable or rebate on the land in question is given to the landowner. Rating incentives can be tied to landholders entering management agreements, thereby introducing the ongoing conservation management of the land.

Conservation Tool Number 10: Rates levies or special environmental levies

The local authority, to supplement local authority funding for biodiversity conservation activities, either in localised areas or across the council area, may introduce an environmental levy scheme. Funds derived form the levy may then be used to acquire conservation land, fund conservation initiatives or finance conservation management.

Conservation Tool Number 11: User and developer contributions

Worldwide councils are increasingly charging on a ‘user pays’ basis for the provision of services that impact directly on the environment, such as water supply, waste disposal and sewage treatment. Charges of this kind lead to increased revenues releasing general rates revenues for conservation management and private landowner incentives. Of particular relevance is the use of development contributions to mitigate the environmental costs of new developments. Land use planning regulations make provision for developers to be levied for the provision of infrastructure and community services associated with urban development. This concept may easily be extended to apply to levies for the management of biodiversity conservation in adjacent areas as an offset for the development.

Conservation Tool Number 12: Loans and Grant funding

Local government may source external “soft” loans or grant funding to support biodiversity conservation initiatives. Funding sources may include loans from financial institutions, grants by application, targeted grants, financial assistance grants and funding partnership grants.

Conservation Tool Number 13: Commercial Concessions

Legally binding agreements may be negotiated between the local authority and private organisations, entrepreneurs, communities or individuals who market goods and services related to protected areas or use natural resources from the protected area or access the area for commercial use and return some share of the profits or a flat fee to the local authority.

Conservation Tool Number 14: Commercial sponsorship

Corporate sponsors may be approached to support biodiversity conservation initiatives where the returns may in kind be financially lucrative to the corporate entity or where they meet the company’s social responsibility objectives.

Conservation Tool Number 15: Direct municipal operational or capital funding

Local authorities can directly fund conservation initiatives on private and public land

Management

Conservation Tool Number 16: Risk Management Strategies

Local authorities are responsible for managing a wide range of environmental risks, including flooding and fire, which may have a direct impact on the management of biodiversity. There is significant potential to integrate risk management with conservation programmes through land use control (removal of alien vegetation), restrictions on development within flood zones and other examples.

Conservation Tool Number 17: Direct Management by Local Government

Local government may take responsibility for the management of conservation activities and conservation lands on both public and private land. On private land this would be through an agreement with the private landowner.

Conservation Tool Number 18: Collaborative management between local government departments

Traditionally each of the types of public land has been managed for a single purpose (e.g. road reserves, cemeteries, public parks etc.). In many cases it would be possible to manage areas for multiple objectives, one of which would be biodiversity conservation. This tool is specifically relevant within the mixed use multi purpose approach constantly advocated by this document.

Conservation Tool Number 19: Collaborative management between land management agencies

Local government only directly manages a portion of al public land within a metropolitan area. Other land management agencies within metropolitan areas that manage, and own, land include Department of Public Works, Transport, Health, Education, State Forest etc. As in tool 18, often this land is managed for a single purpose. Again significant opportunity exists for multi function and multi purpose land management between land management agencies. This tool is also specifically relevant within the mixed use multi purpose approach constantly advocated by this document.

Conservation Tool Number 20: Commercial outsourcing of conservation management

A local authority may contract an external agent to undertake it's operational biodiversity conservation activities. This may be relevant where internal capacity does not exist or where financially it is more cost effective to outsource the function.

Conservation Tool Number 21: Supporting the work of community based groups

The voluntary efforts of community based groups is a central means through which conservation can be delivered. Mechanisms through which local authorities provide support and other resources to community groups for natural resource management include the use of equipment, use of resources, facilities, support staff and funding.

Conservation Tool Number 22: Management Agreements

In broad terms, a management agreement is a contract or binding agreement between a landowner and a third party, in this case regarding the management of natural resources on the land. In general, the agreement would generally restrict land uses that are harmful and prescribe the management actions required to sustain conservation values of the property in the long term.

5.2.2 The Management Model

The precise management model that is applied to each of the sites within the biodiversity network needs to be developed within the context and needs of each particular site and set of circumstances. Having developed broad development planning and land use guidelines for each of the three categories, these must be given effect through the development of a management model that makes use of a one or more (in combination) of the conservation management tools described above. The range of land use guidelines and the range of tools available to be used in many different combinations, present an opportunity for creative approaches to biodiversity conservation. It is imperative that for the vision of an interlinked and connected network across the city that conserves biodiversity while promoting social and economic opportunity be realised, that creative and new approaches and management models be explored and implemented. There needs to be a new and greater focus on partnerships between the City and developers, between the City and communities, between the City and other governmental organisations and between the City and individuals to ensure that the unique biodiversity within Cape Town is conserved for future generations. These new creative approaches and partnerships will allow for healthy living environments with access to quality natural space while still meeting the economic and social needs of development.

5.3 Areas outside the network

As was made clear and stressed throughout the description of the methodology and data used in this study, the results are data dependent. As such, it is likely that over time as Environmental Impact Assessments are done, research botanical surveys completed, areas will be identified that are of particular biodiversity importance but which were not identified within the network described above. How do these areas then fit within the defined network?

Firstly there is a strong level of confidence in the results obtained from the analysis and therefore it is likely that additional sites identified that were not included in the network will be the exception rather than the rule. However, as new information becomes available and as new areas are surveyed and assessed in detail, sites of particular biodiversity value will be identified that haven't yet been included in the network. In this instance the particular site must be assessed according to the context of the entire network. Its vegetation type and contribution to the targets set in this study as well as the context of its geographical location and relation to other areas must be viewed within the city-wide context of the network. Having completed this assessment and the site is deemed to be of enough value and importance to contribute in a positive manner to the overall conservation goals of the city, then the site should be added to the network and a conservation management model developed. The network as defined and depicted within this document must become the focus of conservation and planning efforts within the city, however it must not be viewed as exclusive and unable to evolve and change to include new sites as additional information becomes available.

6. CONCUSLIONS AND RECOMMENDATIONS

The City of Cape Town is a global biodiversity hotspot, and in an urban context, is arguably without parallel in terms of the importance of conservation within a highly complex environment with a multitude of social and economic pressures and needs. To effectively conserve what remains of the City's unique, diverse and endemic biodiversity within this complex environment requires determination, political will, support form all communities and the provision of adequate resources and capacity. The next decade will be the defining period for biodiversity in Cape Town as beyond that, any opportunity to conserve biodiversity will be lost permanently. This places enormous pressure and responsibility on the City's leadership and officials, as they are the last administration that has the opportunity to conserve what is globally unique, for both current and future generations.

Without decisive and committed action, Cape Town's biodiversity will be irreparably lost. The Biodiversity Network, aside from identifying the spectrum of areas that require conservation, highlights the diverse and unique biodiversity in the City. Key recommendations to be taken forward include:

1. Ensuring political commitment to achieving the biodiversity targets
2. Recognising that although the City of Cape Town must take the lead role, conservation of the unique biodiversity must be a shared responsibility with other key government agencies, funding organisations, NGO's and communities
3. Mechanisms must be found to better integrated biodiversity into the urban fabric. Historical concepts of conservation will work well for isolated large areas, however the majority of biodiversity sites will need to be managed and secured through progressive and forward thinking approaches
4. Ongoing monitoring of the state of biodiversity within the City must be initiated
5. Far greater resources must be provided to biodiversity management if any real success in meeting the targets is to be achieved
6. That the next ten years will define whether biodiversity in Cape Town will survive must be broadly and continuously communicated to the leadership of Cape Town as well as its communities.
7. Economic opportunities associated with natural environments must be identified and developed as a means of enhancing the importance of biodiversity on the social needs agenda.
8. The emphasis must move from planning to implementation