

## APPENDIX A:

### Description of methods used for the identification and prioritisation of the Biodiversity Network for the City of Cape Town

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#### 1. Datasets

##### *Vegetation Map*

The original analysis was done using a 1:10 000 scale vegetation map developed by A.B. Low (Low, 2000) and which only covered the City of Cape Town administrative area. This map described 15 vegetation types which were derived by sub-dividing, on the basis of soil/geology and rainfall, the broad vegetation types identified in the Low and Rebelo (1996) national vegetation map.

This local vegetation map was aligned with the National Vegetation Map recently developed by SANBI (Mucina and Rutherford, 2004). This map was used as the basis for the recently completed National Spatial Biodiversity Assessment (NSBA). Aligning the Low (2000) vegetation map with the national map would allow the City of Cape Town to report on the national significance of conservation initiatives within the City.

The two vegetation maps were aligned by Dr A. Rebelo and Mr. A.B. Low, and the results captured into a GIS layer describing the distributions of the aligned vegetation types. The alignment process primarily involved splitting of the types from the Mucina and Rutherford (2004) vegetation map with the types described in the Low (2000) map. The detailed method used to integrate these vegetation types is presented in Appendix 1. This alignment of vegetation maps resulted in 43 vegetation types, which were used as the primary biodiversity elements in the conservation plan.

##### *Plant Species*

Two sources of plant species data were used:

- a. Protea Atlas Project (Rebelo, 1991).
- b. Sites and Species Database (Low, 2002).

The species data were used as secondary inputs after an initial site identification using the vegetation types only. Essentially, these species datasets were used to assess the efficacy of the areas selected using the vegetation types, and to identify where the

network required additional areas for the conservation of these species at known locations.

#### *Planning Units (Natural Habitat Remnants – NHRs)*

The original study made use of a GIS layer describing the boundaries of areas of remnant untransformed (but not necessarily undegraded) vegetation. This original layer was subjected to ground-truthing, and was updated with the 1998 1:10 000 colour aerial photography (the latest set available at the time). Subsequent to this, the City has produced an updated version of the aerial photography. From January to May 2006 the CCT, in partnership SANBI and Cape Nature, updated the remnant layer using 2005 aerial photography. During this process the City's remnant layer was also integrated with the remnant layer being used by Cape Nature and derived from the Lowlands study. The planning unit layer consisted of 661 remnants, ranging in size from just over 1ha to 7,055 ha, and covering an area of 98,017.1ha (39.4% of the City).

#### *Protected Areas*

Protected area layers originally received from the City of Cape Town, as well as the Core Sites database were used to assign conservation status to the planning units. This information was subjected to an iterative assessment process with City officials before general agreement was reached on the distribution of conserved remnants within the City. 114 of the 661 remnants were considered to be conserved, covering an area of 52,654.57 (21.1% of the City).

## **2. Conservation target setting**

#### *Vegetation types*

Targets were graduated based on the premise that vegetation types would have differential requirements for protection. In other words, targets were not set as uniform for all types. Area targets were calculated as the percentage of the estimated historical area of each vegetation type required within a City conservation network. This has become accepted as a standard approach for target setting in systematic conservation planning.

Using other conservation planning studies as a starting point, and a process of stakeholder consultation, the following criteria were used to determine target values for vegetation types:

- a. **Historical rarity within the City of each vegetation type (expressed as a percentage of the City area covered by the historical distribution of each type).**  
This was based on the premise that types with small natural areas need larger targets due to greater risk to unprotected portions from extensive potential disturbances (Pressey *et al.*, 2003).
- b. **Percentage of the national vegetation types, historically occurring in the City.**  
This criterion emphasises the importance of the City for conserving those types which are endemic to the area. Considering the high levels of transformation of the City's natural environments, it is important to ensure that as much of the remaining area of those types limited to the City are protected. The amount of upward

adjustment of target values is dependent on the degree of endemism associated with each vegetation type.

**c. The degree of transformation of vegetation types within the City.**

This criterion serves to ensure larger target values (particularly in terms of the percentage of extant vegetation) for those vegetation types which have historically been extensively transformed by development. While a direct correlation between historic loss and future loss is not clear for all vegetation types, the extent of historic loss does give an indication of the threat status of each type.

Firstly, to determine starting/base target values, three rarity classes were identified using the historical extent of each vegetation community (criteria a listed above). Classes were identified using a Natural Breaks Classification system (Jenks optimisation). Those vegetation types belonging to the rarest class were assigned an arbitrary 20% target; intermediate class communities were assigned 15%, while the commonest were assigned a 10% target.

These target values were then adjusted upwards on the basis of the percentage of the national type occurring in the City (criteria b above) to derive the base target values. Vegetation types with less than 35% of the national distribution falling in the City were adjusted upwards by 0%, types between 35% and 99% were adjusted upwards by 5%, with those occurring entirely within the City (100%) were adjusted upwards by 10%. This resulted in base target values ranging between 10% and 30%.

The base target values were then used to produce the final targets percentages. This was undertaken by altering the base target by the degree of vegetation transformation. Vegetation community transformation (t) was calculated using the current (ce) and historical (he) extent of each community type:

$$t = 2 - ce/he$$

This transformation value (t) was used to calculate the final target for each vegetation type:

$$\text{Final Target} = \text{Base Target} * t$$

This yielded final target values ranging from 15% to 60% (Table 1).

These target values were then converted to area values by multiplying the percentage values by the historic area. These area values represent the targets used in the selection of the conservation network.

For 21 of the 43 vegetation types the conservation targets cannot be attained due to insufficient current area within the City remnants. Eleven of these 21 historically covered <1% of the City. Two of these smaller vegetation types (Swartland Shale Renosterveld on older non-aeolian colluvium and Cape Flats Dune Strandveld on recent non-aeolian colluvium) have been completely lost within the City.

Using similar criteria and categories to those used in the NSBA, each vegetation type was assigned an ecosystem status (Table 1).

The target areas were amalgamated at the national vegetation type level to compare with those set by the National Spatial Biodiversity Assessment (Table 2). National guidelines being drawn up by SANBI for conservation target setting suggest that local-scale conservation plans should as a minimum set targets on the basis of the proportional area of each national type occurring within the local planning domain. Furthermore, in instances where finer scale vegetation maps are available for local conservation planning, as a minimum the targets set for the finer scale types should be set on the basis of the proportional area of each type within the local planning domain. It is important to note that these guidelines talk about minimum target values. Local targets can be set separately using criteria focussed on local ecological characteristics and aimed at ensuring biodiversity maintenance within the local planning domain.

It is important to understand that any target value under 100% of the historic area of a vegetation type will result in the loss of biodiversity. The lack of accurate and up-to-date data on the distribution of all elements of biodiversity (for example poorly known and cryptic groups like invertebrates, fungi etc) necessitates the use of vegetation types as surrogates for biodiversity. Tests of surrogates have shown that surrogacy is at best only approximate (Kirkpatrick and Brown, 1994; Howard *et al.*, 1998). This suggests that even though some of the target values may be considered as high, they will still fall substantially short of what is required to ensure the conservation of all remaining elements of the City's biodiversity. Even conserving 100% of the extant native vegetation will more than likely be insufficient for the preservation of the City's full remaining complement of biodiversity. Extinction debt, resulting from habitat loss and fragmentation, could result in the loss of species even if the status quo is maintained (Tilman *et al.*, 1994). This should serve to emphasise the importance of conserving the remaining extant vegetation, to at least minimise the loss of biodiversity within the City.

#### *Plant species*

A simple target for each species was set on the basis of the number of known locations. Species with 5 or less locations had a target of 100% of these locations. Species with 6 or more locations were assigned a target of 80% of known locations. These targets were based on a similar premise to that used for the inclusion of rarity as a criterion for determining vegetation type target values. In other words, rarer species will be assigned relatively higher target values (as a percentage of known locations) than more common species.

**Table 1: Historic and current (remnant) distribution of the vegetation types in Cape Town presented together with the conservation targets and the variables used to determine these. The ecosystem status of each type is also shown, with the critically endangered types (i.e. those where the target area exceeds the current available area) shown in red.**

National Vegetation Type	Sub Type	Historic Area in Hectares	Historic % of Study Area	Base Target	Remnant Area (Hectares)	% Lost	Transformation Index	National % in CCT factor	Adjusted Base Target	Adjusted Final Target %	Adjusted Actual Target (Hectares)	Adjusted Difference (Current-Target) (Hectares)	Ecosystem Status
Atlantis Sand Fynbos	Strandveld/Fynbos transition (on calcareous/acidic/neutral sands)	8930.44	3.66	20	7,734.43	13.39	1.13	5	25	28.35	2531.61	5202.82	LT
Atlantis Sand Fynbos	on marine-derived acid sands	10798.98	4.42	15	6,958.64	35.56	1.36	5	20	27.11	2927.86	4030.78	VU
Atlantis Sand Fynbos	on recent non-aeolian colluvium	384.53	0.16	20	186.45	51.51	1.52	5	25	37.88	145.65	40.80	EN
Atlantis Sand Fynbos	on older non-aeolian colluvium	7655.78	3.13	20	1,699.90	77.80	1.78	5	25	44.45	3402.91	-1703.01	CE
Boland Granite Fynbos	on Granite	3528	1.44	20	2701	23	1	0	20	25	871	1830	VU
Boland Granite Fynbos	on recent non-aeolian colluvium	5,853.37	2.40	20	3,402.49	41.87	1.42	0	20	28.37	1,660.85	1,741.64	EN
Boland Granite Fynbos	older non-aeolian colluvium	180.13	0.07	20	47.41	73.68	1.74	0	20	34.74	62.57	-15.17	CE
Cape Flats Dune Strandveld	on Sandstone	192.90	0.08	20	149.60	22.45	1.22	10	30	36.73	70.86	78.74	VU
Cape Flats Dune Strandveld	on sands over or on limestone	4,200.26	1.72	20	2,757.01	34.36	1.34	10	30	40.31	1,693.05	1,063.96	VU
Cape Flats Dune Strandveld	on Shale	296.31	0.12	20	187.00	36.89	1.37	10	30	41.07	121.69	65.31	VU
Cape Flats Dune Strandveld	on sands	35,376.44	14.49	10	15,994.27	54.79	1.55	10	20	30.96	10,951.72	5,042.54	EN
Cape Flats Dune Strandveld	on recent non-aeolian colluvium	80.44	0.03	20	0.00	100.00	2.00	10	30	60.00	48.26	-48.26	CE
Cape Flats Sand Fynbos	on recent non-aeolian colluvium	492.15	0.20	20	169.35	65.59	1.66	10	30	49.68	244.48	-75.13	CE
Cape Flats Sand Fynbos	on older non-aeolian colluvium	4,116.03	1.69	20	1,184.91	71.21	1.71	10	30	51.36	2,114.15	-929.24	CE
Cape Flats Sand Fynbos	on marine-derived acid sands	49,777.86	20.38	10	8,030.07	83.87	1.84	10	20	36.77	18,305.13	-10,275.06	CE
Cape Flats Sand Fynbos	Strandveld/Fynbos transition (on calcareous/acidic/neutral sands)	268.04	0.11	20	7.93	97.04	1.97	10	30	59.11	158.44	-150.51	CE
Cape Lowland Freshwater Wetlands	on recent non-aeolian colluvium	451.97	0.19	20	260.74	42.31	1.42	0	20	28.46	128.64	132.10	EN
Cape Lowland Freshwater Wetlands	Wetlands	944.47	0.39	20	124.38	86.83	1.87	0	20	37.37	352.91	-228.53	CE
Cape Winelands Shale Fynbos	on Shale	1,961.84	0.80	20	1,022.96	47.86	1.48	5	25	36.96	725.18	297.77	EN
Cape Winelands Shale Fynbos	on recent non-aeolian colluvium	7.52	0.00	20	0.03	99.60	2.00	5	25	49.90	3.75	-3.72	CE
Elgin Shale Fynbos	on Shale	242.44	0.10	20	241.73	0.29	1.00	0	20	20.06	48.63	193.10	LT
Hangklip Sand Fynbos	on sands	1041	0.43	20	798	23	1	5	25	31	321	478	VU
Hangklip Sand Fynbos	on marine-derived acid sands	2,357.55	0.97	20	1,185.43	49.72	1.50	5	25	37.43	882.42	303.02	EN
Kogelberg Sandstone Fynbos	on Sandstone	10,671.20	4.37	15	10,608.32	0.59	1.01	0	15	15.09	1,610.11	8,998.21	LT
Lourensford Alluvium Fynbos	on recent non-aeolian colluvium	4,819.25	1.97	20	646.68	86.58	1.87	10	30	55.97	2,697.54	-2,050.86	CE

National Vegetation Type	Sub Type	Historic Area in Hectares	Historic % of Study Area	Base Target	Remnant Area (Hectares)	% Lost	Transformation Index	National % in CCT factor	Adjusted Base Target	Adjusted Final Target %	Adjusted Actual Target (Hectares)	Adjusted Difference (Current-Target) (Hectares)	Ecosystem Status
North Peninsula Granite Fynbos	on recent non-aeolian colluvium	857	0.35	20	627	27	1	10	30	38	326	301	VU
North Peninsula Granite Fynbos	on Granite	1,140.40	0.47	20	734.17	35.62	1.36	10	30	40.69	463.99	270.18	VU
Peninsula Sandstone Fynbos	on Sandstone	20,615.85	8.44	15	19,363.26	6.08	1.06	10	25	26.52	5,467.11	13,896.15	LT
Peninsula Sandstone Fynbos	on Mudstone	884.94	0.36	20	784.72	11.32	1.11	10	30	33.40	295.55	489.17	LT
Peninsula Shale Fynbos	on Shale	456.98	0.19	20	314.11	31.26	1.31	5	25	32.82	149.96	164.15	VU
Peninsula Shale Fynbos	on recent non-aeolian colluvium	805.39	0.33	20	369.19	54.16	1.54	5	25	38.54	310.40	58.79	EN
Peninsula Shale Renosterveld	on Shale	1,882.89	0.77	20	290.07	84.59	1.85	10	30	55.38	1,042.71	-752.64	CE
Peninsula Shale Renosterveld	on recent non-aeolian colluvium	491.86	0.20	20	5.41	98.90	1.99	10	30	59.67	293.49	-288.08	CE
South Peninsula Granite Fynbos	on recent non-aeolian colluvium	3,683.78	1.51	20	1,274.36	65.41	1.65	10	30	49.62	1,827.96	-553.60	CE
South Peninsula Granite Fynbos	on Granite	3,497.44	1.43	20	1,133.03	67.60	1.68	10	30	50.28	1,758.55	-625.53	CE
Southern Afrotropical Forest		301.29	0.12	20	298.80	0.83	1.01	0	20	20.17	60.76	238.04	LT
Swartland Alluvium Fynbos	on Malmesbury Sandstone	1,742.41	0.71	20	88.32	94.93	1.95	0	20	38.99	679.30	-590.98	CE
Swartland Granite Renosterveld	on Granite	5,680.67	2.33	20	1,522.82	73.19	1.73	0	20	34.64	1,967.70	-444.89	CE
Swartland Granite Renosterveld	on recent non-aeolian colluvium	154.36	0.06	20	39.73	74.26	1.74	0	20	34.85	53.80	-14.07	CE
Swartland Shale Renosterveld	on Shale	41,484.95	16.99	10	3,823.32	90.78	1.91	0	10	19.08	7,914.66	-4,091.34	CE
Swartland Shale Renosterveld	on recent non-aeolian colluvium	4,875.99	2.00	20	246.56	94.94	1.95	0	20	38.99	1,901.08	-1,654.52	CE
<b>Swartland Shale Renosterveld</b>	<b>on older non-aeolian colluvium</b>	<b>20.59</b>	<b>0.01</b>	<b>20</b>	<b>0.00</b>	<b>100.00</b>	<b>2.00</b>	<b>0</b>	<b>20</b>	<b>40.00</b>	<b>8.24</b>	<b>-8.24</b>	<b>CE</b>
Swartland Silcrete Renosterveld	on recent non-aeolian colluvium	1,009.09	0.41	20	220.44	78.15	1.78	0	20	35.63	359.55	-139.10	CE

**Table 2: Summary of historic and current (remnant) distribution of the vegetation types in Cape Town, amalgamated at the level of the national vegetation types (SANBI vegetation map, Mucina and Rutherford, 2004). Amalgamated target values are shortfalls are also presented, and shown in comparison to targets (total and proportional) set by the National Spatial Biodiversity Assessment (NSBA).**

National Vegetation Type	Historic SA Area (Hectares)	Historic Cape Town Area (Hectares)	% in Cape Town	NSBA Ecosystem Status	NSBA Target %	Proportional Cape Town Target %	Average CCT Target %	Sum of Actual CCT Target Area (Hectares)	Summarised CCT Target %	Difference between CCT and NSBA Targets	CCT Remnant Area (Hectares)	Difference between Remnant Area and Target Area
Atlantis Sand Fynbos	69800.63	27769.72	39.78	EN	30	11.94	34.45	9008.04	32.44	2.44	16,579.43	7,571.39
Boland Granite Fynbos	49,902.81	9,561.36	19.16	EN	30	5.75	29.27	2,594.38	27.13	-2.87	6,150.85	3,556.47
Cape Flats Dune Strandveld	40,146.35	40,146.35	100.00	EN	24	24.00	41.81	12,885.59	32.10	8.10	19,087.87	6,202.29
Cape Flats Sand Fynbos	54,654.07	54,654.07	100.00	CE	30	30.00	49.23	20,822.20	38.10	8.10	9,392.27	-11,429.93
Cape Lowland Freshwater Wetlands	7,487.60	1,396.44	18.65	VU	24	4.48	32.91	481.55	34.48	10.48	385.12	-96.43
Cape Winelands Shale Fynbos	8,613.39	3,231.74	37.52	EN	30	11.26	39.56	1,189.30	36.80	6.80	1,706.29	516.99
Elgin Shale Fynbos	27,947.73	242.44	0.87	CE	30	0.26	20.06	48.63	20.06	-9.94	241.73	193.10
Hangklip Sand Fynbos	8,121.47	3,398.30	41.84	VU	30	12.55	34.13	1,203.19	35.41	5.41	1,983.84	780.66
Kogelberg Sandstone Fynbos	91,527.99	10,671.20	11.66	LT	30	3.50	15.09	1,610.11	15.09	-14.91	10,608.32	8,998.21
Lourensford Alluvium Fynbos	4,819.25	4,819.25	100.00	CE	30	30.00	55.97	2,697.54	55.97	25.97	646.68	-2,050.86
Peninsula Granite Fynbos	9,178.59	9,178.59	100.00	EN	30	30.00	178.64	4,376.63	47.68	17.68	3,768.42	-608.20
Peninsula Sandstone Fynbos	21,500.79	21,500.79	100.00	LT	30	30.00	29.96	5,762.66	26.80	-3.20	20,147.98	14,385.32
Peninsula Shale Renosterveld	2,374.74	2,374.74	100.00	CE	26	26.00	57.52	1,336.20	56.27	30.27	295.49	-1,040.72
Southern Afrotropical Forest	81,520.97	301.29	0.37	LT	34	0.13	20.17	60.76	20.17	-13.83	298.80	238.04
Swartland Alluvium Fynbos	46,984.43	1,742.41	3.71	EN	30	1.11	38.99	679.30	38.99	8.99	88.32	-590.98
Swartland Granite Renosterveld	94,744.78	5,835.02	6.16	CE	26	1.60	34.75	2,021.50	34.64	8.64	1,562.55	-458.95
Swartland Shale Renosterveld	494,576.60	46,381.53	9.38	CE	26	2.44	32.69	9,823.98	21.18	-4.82	4,069.88	-5,754.09
Swartland Silcrete Renosterveld	9,984.86	1,009.09	10.11	CE	26	2.63	35.63	359.55	35.63	9.63	220.44	-139.10

Notes:

1. Following types Historic Area in SA values were adjusted to equal the Historic Cape Town Area: Cape Flats Dune Strandveld; Cape Flats Dune Strandveld, Cape Flats Sand Fynbos; Lourensford Alluvium Fynbos; Peninsula Granite Fynbos; Peninsula Sandstone Fynbos; Peninsula Shale Renosterveld. These types only occur in the area defined by the CCT, but their boundaries were adjusted by Tony Rebelo and Barry Low when the Low and SANBI veg maps were integrated. The areas and polygons in the original SANBI map do therefore no longer fully correlate to those in the CCT Low Veg Map used in the analysis
2. Cape Winelands Shale Fynbos includes Peninsula Shale Fynbos (the latter is not recognised as a national type).  
The Peninsula Granite Fynbos includes both North and South types recognised by Rebelo and Low (national only recognises one type).

### 3. Site selection

The ArcView 3.2 extension C-Plan was used to select an optimal and efficient set of remnants to meet the conservation targets. C-Plan is a conservation-planning tool that provides the tools for the application of a logical and sequential planning process.

The process of analysis using C-Plan followed the following steps:

1. **Calculate achievable targets based on the remaining extent of each vegetation type.**  
C-Plan assesses the available area of each vegetation type and uses this to determine the actual areas that can be conserved. Thus, for those vegetation types where the current available area is less than the graduated target, the achievable target will be equal to the former. i.e., all remnants are selected irrespective of size. For those types with available area greater than the target, C-Plan uses the target values.
2. **Review the extent to which achievable targets are met by existing conservation areas.**  
The area of each vegetation type falling in existing conserved areas is then determined. The difference between this area and the target area is the remaining area required to achieve the target.
3. **Determine the irreplaceability of non-conserved areas based on contribution to attaining the remaining target areas.**  
The irreplaceability of the non-conserved remnant areas is then calculated, based on their contribution to achieving the remaining target areas.
4. **Use an algorithm based on the biological planning criteria to select additional areas required to achieve targets.**  
An algorithm (known as a minimum set algorithm) was developed and applied to the selection of remnant areas required to meet the remaining target values. The algorithm made use of the following selection rules:
  - i. remnant irreplaceability,
  - ii. size,
  - iii. percentage contribution,
  - iv. vegetation type diversityRules ii-iv are only used if ties occur.
5. **Using C-Plan's ability to track target attainment for individual elements of biodiversity, the contribution of the areas selected for vegetation types to attaining targets for plant species was assessed and additional areas selected where required.**  
C-Plan enables users to view the percentage of set target values attained for each element of biodiversity being used.  
Firstly, the contribution of the currently conserved sites and sites selected for attainment of vegetation targets toward meeting the species targets was assessed. For those species with outstanding targets, a minimum set algorithm was used to select additional sites. The algorithm used the following selection rules:
  - i. remnant irreplaceability,
  - ii. size,
  - iii. percentage contribution
  - iv. species richnessRules ii-iv are only used if ties occur.



#### **4. Corridor modelling**

Overall, the maintenance of connectivity among conservation areas is seen as one of the most important ways of ensuring the persistence of ecological processes, and thus the long-term persistence of biodiversity. While smaller scale processes were catered for in the attainment of the vegetation and species pattern targets, broad scale connectivity was assessed through a spatial modeling process known as friction analysis.

Friction analysis was undertaken to define spatially explicit corridors encompassing the biodiversity network. A friction surface (which divides the study area into grid cells) was developed in which low values are used for areas where a high compatibility for biodiversity exists and high values are used for land uses that create effective barriers to connectivity (Table 3). The friction surface is then used to derive a cost (to connectivity) surface, where the cost assigned to each cell is dependent on the minimum accumulated friction value when moving from an individual cell to a range of targets. Movement can occur in all 8 cardinal directions. The cost surface is then used to define pathways from a starting point to target areas. By examining all pathways along known gradients such as altitude or examining pathways to connect critical ecosystems (mountains to mountains or coasts to coasts) a network of flows is generated which will describe areas most compatible for maintaining connectivity. The networks of paths are then converted to lines, which are finally buffered to provide a corridor planning framework.

The development of these spatial modelling approaches ensures that ecological gradients and possible effects of global changes are managed within corridors. Identified corridors linked the following significant areas, Zandvlei, Macassar, Gordons Bay, Cape Point, Noordhoek Wetlands, West Coast, Mamre, and Paardeberg) Effectively these corridors optimise routes containing natural vegetation and all major vegetation types. The advantages of this procedure is that it looks at the viability of patches in relation to where neighbouring viable patches are located and is therefore fully spatially explicit.

**Table 3: Friction values ascribed to various features and landscapes for the development of the corridors for conservation management. The base value of 1 is all areas that are either protected or been selected for protection. As friction values increase the area becomes increasingly unattractive for biodiversity. The corridors ensure the viability of existing biodiversity is optimised through a network of areas most compatible for supporting it.**

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**Base Friction = 1**

Existing Nature Reserves, Core Floral Sites, Selected remnants (all), Wetlands, Estuaries, Vleis

**Friction = 3**

Rivers with natural banks, non-selected remnants

**Friction = 5**

Dams, waste water treatment works' water bodies

**Friction = 10**

Major powerlines, reservoirs, detention ponds, retention

**Friction = 15**

Irrigation ponds, canals, composite canal, open channels, weirs

**Friction = 30**

Major Roads and Freeways, Urban Open Spaces

**Friction = 60**

Low intensity agriculture\*, wheat fields\*, built up areas

**Fiction = 120**

High intensity Agriculture, Vegetable growing, Commercial areas

**Friction = 240**

Industrial areas, Settlements

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\*Originally run with frictions of 120 but no difference was observed in the network

## **5. Site prioritisation**

Prioritisation analyses were undertaken using ArcGIS 9.1 (ESRI, Redlands, California). While a single set of decision rules aimed to integrate the terrestrial and aquatic elements of the network, in practice the analysis needed to be undertaken separately using the separate datasets for the terrestrial component of the Biodiversity Network, rivers and wetlands.

### *Summary of GIS methods used in assigning prioritisation of selected planning units, wetlands and rivers*

The NHRs, wetlands and rivers were provided in three separate GIS layers:

1. The planning unit layer describing the terrestrial remnants, which were selected as Key Nature Conservation Areas during the conservation planning analysis. This layer also included the current network of protected areas and the Core Flora Sites.
2. The wetland layer described a set of 14 wetlands which were assigned importance and sensitivity by the study entitled "*River and vlei assessment and monitoring in the CMA: Revisiting and refining the river importance and sensitivity maps*". This river and vlei assessment study actually included 17 wetlands, however the location and extent of three of these were not available in the data supplied by the City of Cape Town.
3. The river layer described the river centerlines and separate reaches for the primary riverine systems in the study area. This data was also used by the river and vlei monitoring and assessment study to assess the ecological importance and sensitivity of these key systems.

The decision tree for prioritisation of the selected planning units, wetlands and rivers into A, B and C categories (Table 4) was then applied to each individual through a spatial model developed using the Model Builder Extension for ArcGIS 9.1. Three separate sub-models were developed for each of the three layers.

1. Each NHR was attributed for the information needed by the decision tree:
  - a) Protected area of core flora site status (yes or no).
  - b) Occurrence of at least 5% of the extant distribution of the 19 critical vegetation types contained by the NHRs. NOTE: the critical vegetation types are those for which the extant area is less than that required by the conservation targets (yes or no).
  - c) NHR area
  - d) Irreplaceability value as assigned by the Key Conservation Areas study (this included irreplaceability values for the vegetation and species analyses).

The GIS model stepped through a series of selections based on the criteria for each rule within the decision tree and assigned each planning unit with a category based on its compliance with each rule. The decision tree and model were designed in such a way that each planning unit was assigned the highest category in cases where more than one category could apply. The model also kept an audit of which rules applied to each planning unit.

2. Each wetland feature was assigned a value for wetland importance class as defined in the river and vlei assessment and monitoring study. The wetland model used this value during the process of stepping through a series of selections based on the criteria for each rule in the decision tree that applied to wetlands. Using this process, the highest relevant prioritisation category was assigned to each wetland feature.
3. Each river feature was assigned a value for ecological priority ranking as defined in the river and vlei assessment and monitoring study. The river model used this value during the process of stepping through a series of selections based on the criteria for each rule in the decision tree that applied to rivers. Using this process, the highest relevant prioritisation category was assigned to each river feature.

**Table 4: Decision rules applied to prioritise terrestrial planning units, wetlands and riverine features.**

Rule 1: Is the planning unit a protected area or a Core Botanical Site? – Yes, then A
Rule 2: Does the planning unit contain more than 5% of the extant distribution of 1 of the 21 critical vegetation types? – Yes, then A
Rule 3: Is the planning unit $\geq 10$ ha in area and have an irreplaceability value of $\geq 0.9$ ? – Yes then A
Rule 4: Is it a wetland of high to very high importance class or a river reach of extreme or high ecological priority? – Yes then A
Rule 5: Does the planning unit have an irreplaceability value of between $\geq 0.75$ and $< 0.9$ , and is $\geq 10$ ha in area. – Yes then A
Rule 6: Does the planning unit have an irreplaceability value of between $\geq 0.75$ and $< 0.9$ ? – $< 10$ ha in area - Yes then B
Rule 7: Does the planning unit have an irreplaceability value of $< 0.75$ and is $> 5$ ha in area? Is it a wetland of moderate importance class or a river reach of moderate ecological priority? – Yes then B, No then C
Rule 8: Remainder of planning units not assigned a category in Rules 1 – 7 are categorised as C

## 6. Identification of biodiversity nodes

Node identification was undertaken using ArcGIS 9.1 (ESRI, Redlands, California).

A series of spatial analyses (particularly nearest neighbour analysis) were undertaken to obtain the required data needed to identify nodes. The nodes were then identified by stepping through a decision tree planning units into nodes. A decision tree was then implemented This involved implementing a series of rules in a decision tree structure (Table 5) within the GIS environment through a series of spatial queries in order to identify the biodiversity nodes and their constituent planning units/wetlands/ivers.

Iterations of the nodes were presented to officials of the Environmental Management Department (City of Cape Town) for comment and refinement.

**Table 5: Decision rules applied to identify biodiversity nodes consisting of terrestrial planning units, wetlands and riverine features.**

<p><b>Rule 1: Is it a large protected area/planning unit/wetland greater than 100 hectares?</b> YES? - becomes a node/part of a node NO? - go to rule two</p> <p><i>Justification:</i> <i>100 ha represents a ten-fold increase in size compared to the threshold of 10 ha used in the ranking of the planning units. A collective area of planning units smaller than this would not have a significant impact with respect to the overall reserve network. One larger area is easier to manage compared with many small areas.</i></p> <p><b>Rule 2: Are there several protected areas/planning units/wetlands adjacent and <u>physically</u> connected that have a summed area of greater than 100 hectares?</b> YES? – together these areas form a node NO? - go to Rule 4</p> <p><b>Rule 3: There are nodes (identified in 1 or 2 above) that are closer than 1 km to each other.</b> Yes? – these nodes are combined into a single node/nodal cluster No? – these remain as individual nodes</p> <p><b>Rule 4: There are protected areas/planning units/wetlands that are closer than 1 km to a node identified in 1, 2 or 3 above?</b> YES? -become part of a node/nodal cluster NO?- end of decision tree</p>
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## APPENDIX 1:

### WORK ON VEGETATION TYPES COVERAGE OF THE CMA

Tony Rebelo, SANBI, 9 May 2006

The coverage of vegetation types (from the Low vegetation types) for the Cape Town Metropolitan Area was obtained from Grant Benn of GISCOE .

2 fields were added to the database table:

- NATVEGMAP: These are the names of the units in the SANBI National Vegetation Map
- VEGSUBTYPE: This is the subcategory of the National Vegetation Map Units that were recognized by Barrie Low.

The following polygons were added:

1. One (with subtypes) Cape Winelands Shale Fynbos on the Tygerberg.
2. One Swartland Silcrete Renosterveld.
3. Two Lourensford Alluvium Fynbos.
4. One Swartland Alluvium Fynbos.
5. Several polygons for Southern Afromontane Forest.

The added polygons for 1 and 4 above were offset by 40-100m, but being small, were adopted anyway, pending better data: where possible, the finer scale boundaries of the base map were adopted.

The following changes were effected; these are confined to the two fields of the database table:

- Sand Fynbos now becomes three types: Atlantis, Hangklip and Cape Flats Sand Fynbos.
- Swartland Silcrete Renosterveld is added to the vegetation types.
- Lourensford Alluvium Fynbos is added to the vegetation types.
- Shale Fynbos now becomes three types: Peninsula, Elgin and Cape Winelands.
- Shale Renosterveld becomes two types: Peninsula and Swartland.
- Granite Fynbos becomes two types: Peninsula and Boland.
- Sandstone Fynbos becomes Peninsula and Kogelberg Sandstone Fynbos, and a subtype of Sandstone Fynbos on Mudstone has been added.

The following of Barrie's vegetation types becomes realigned:

- Colluvial scree over granite changes from Sand Fynbos to Granite Fynbos on the eastern edge of the Peninsula Mountain Chain.
- Hangklip Sand Fynbos replaces Cape Flats Dune Strandveld on the older inland sands of the central Peninsula.
- Fynbos/Strandveld ecotone becomes a subtype of Sand Fynbos and not a separate type in terms of the national map.

Several problems were found with polygons with incorrect or missing geologies: the largest of these were corrected, but a few (ca 45) slivers were not corrected as their area is insignificant. Reference for these corrections was made to the 1:50 000 geology series paper maps for the Cape Peninsula and Cape Flats. Suggested use of types and subtypes is summarized in Table 1.

Table 1: Vegetation types and subtypes resulting from alignment of vegetation types with National Vegetation Map.

National Vegetation Types = NATVEGMAP	Subtypes = VEGSUBTYPE	Notes	Running Total of Subtypes
Atlantis Sand Fynbos	5	Disregard "empty" subtype = 4 subtypes	4
BEACH	1	Disregard	
Boland Granite Fynbos	3		7
Cape Flats Dune Strandveld	5		12
Cape Flats Sand Fynbos	4		16
Cape Lowland Freshwater Wetlands	2	THIS ANALYSIS?	
Cape Winelands Shale Fynbos	2	Treat as only one subtype = 1 subtype	17
Elgin Shale Fynbos	1		18
Hangklip Sand Fynbos	2		20
Kogelberg Sandstone Fynbos	1		21
Lourensford Alluvium Fynbos	1		22
Outside	0	1 polygon: Disregard	
Peninsula Granite Fynbos	5	Use only 3 larger units = 3 subtypes	25
Peninsula Sandstone Fynbos	2		27
Peninsula Shale Fynbos	2		29
Peninsula Shale Renosterveld	2		31
RECLAIMED	1	Disregard	
Southern Afrotemperate Forest	6	Treat as only one subtype = 1 subtype	32
Swartland Alluvium Fynbos	1		33
Swartland Granite Renosterveld	2	Disregard "empty" subtype = 1 subtype	34
Swartland Shale Renosterveld	3	Disregard "empty" subtype = 2 subtypes	36
Swartland Silcrete Renosterveld	1		37