

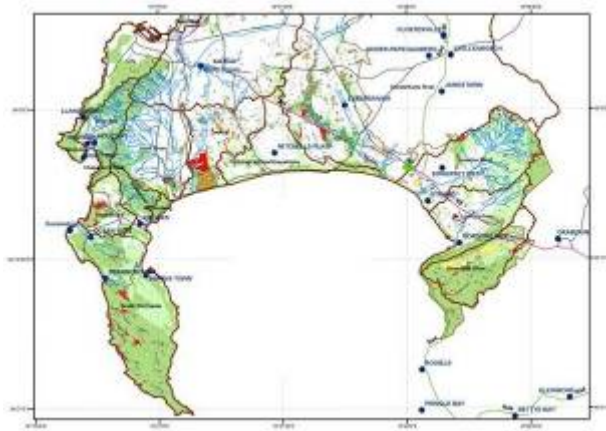


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## Prioritisation of City Wetlands

Submitted to:  
**CITY OF CAPE TOWN**  
Department of Environmental Resource Management



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## 1 INTRODUCTION

### 1.1 Background

The Freshwater Consulting Group (FCG) (Phases 1, 3 and 4) and Jeffares and Green (Pty) Ltd (Phase 2) recently completed a desktop spatial wetlands layer for the City of Cape Town (Ewart-Smith *et al.*, 2008), referred to as the City Wetlands Map. The complete wetlands layer comprises 7677 polygons classified as wetlands, some of which lie outside the City boundary. A total of 3503 wetlands are classified as known anthropogenic features, while the remaining 4174 wetlands are considered to be natural or semi-natural. The City Wetlands Map was produced from a largely desktop assessment of aerial photography, with field verification of a subset of the mapped wetlands, including those areas where existing field work had already been undertaken by FCG and other consultants for separate studies (see Snaddon *et al.*, 2009). Where field verification was undertaken, the confidence with which the wetlands were mapped was high, while a low confidence was associated with the mapping of many of the wetlands.

In order for the City Wetlands Map to be integrated into the terrestrial Biodiversity Network through the incorporation of a representative set of wetland types, it is necessary to prioritise the full complement of City wetlands for the conservation of biodiversity within the City. The City aims to publish its Biodiversity Network as a Bioregional Plan, as required by the national Biodiversity Act (NEM:BA). The prioritised wetlands map must therefore lead to the categorisation of wetlands into the biodiversity categories prescribed for Bioregional Plans, i.e. Critical Biodiversity Areas (CBAs), and ecological support areas (ESAs).

This report describes the methods used for the ranking of wetlands, according to a set of criteria that assess overall biodiversity “value”, within each of the wetland types found in the City of Cape Town. Recommendations for the integration of the prioritised Wetlands Map with the terrestrial Biodiversity Network are made.

### 1.2 Terms of reference for prioritisation

The specific terms of reference for the prioritisation component of this phase of work, as provided by the City of Cape Town, were as follows:

- Attend a project initiation meeting to discuss the scope of work, proposed methodology and identify data requirements;
- Produce a prioritisation protocol for the City’s natural and semi-natural wetlands that has general support from the local wetland community (e.g. Western Cape Wetlands Forum);
- Rank all the natural and semi-natural wetlands in the City according to the prioritisation protocol and indicate (with reasons) which of these wetlands should be included in the Biodiversity Network/ Bioregional Plan;
- Submit a brief report outlining the methodology, the prioritisation protocol, results of applying the protocol and conclusions;
- Submit an updated City wetlands map, including the wetland priority category as an attribute field, and
- Present the findings to City staff at the end of the project.

### 1.3 Limitations

This project did not attempt to integrate the prioritised City Wetlands Map with the terrestrial component of the Biodiversity Network in order to provide an integrated conservation plan, but provided each wetland within the Map with a ranking and proposed biodiversity category.

This phase of work did not attempt a prioritisation of riverine channels, but did include riverine wetlands.

Prioritisation was done at a local scale, within the city, excluding any wetlands on the City Wetlands Map that fall outside the City boundary (these will remain on the City Wetlands Map, however). It is noted that a broader scale prioritisation would lead to a different result.

Due to the fact that there is insufficient information to map or assess the original extent of wetlands in the City of Cape Town, the prioritisation of wetlands and any reference to conservation targets does not take into account factors such as the rate of loss of wetlands or wetland types, or the area remaining for each wetland type.

### 1.4 Definitions

The National Wetland Classification System developed for the National Wetland Inventory defines **wetlands** as “*areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tides does not exceed ten meters*” (Ewart-Smith *et al.* 2006). This is an adaptation of the definition adopted by the Ramsar Convention, which limits marine water to a depth of six meters at low tide (Davis 1994). Accordingly, wetlands are areas where water is the primary factor controlling the environment and therefore, wetlands develop in areas where soils are saturated or inundated with water for varying lengths of time and at different frequencies. Within this classification, three primary systems are identified, namely Marine, Estuarine and Inland. For the purposes of this project, only Estuarine and Inland systems were identified and mapped and of the Inland systems, the wetland category “channels” (i.e. river channels) were excluded from the wetland layer because these have already been included in the City’s river centre-line GIS layer. Therefore, wetlands included within the wetland layer generated during this project fall largely within the wetland definition outlined in the South African Water Act (Act 36 of 1998) as “*land which is transitional between terrestrial and aquatic systems, where the water table is usually at, or near the surface, or the land is periodically covered with shallow water and which land in normal circumstances supports, or would support, vegetation adapted to life in saturated soil*”. Large vleis / coastal lakes are included in the wetlands addressed.

The term **biodiversity**, as used in this report, refers to biological diversity which, as defined by the Convention on Biological Diversity is “*the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems*”. The freshwater community tends to refer to the following attributes of biodiversity, namely “composition”, which describes what is there and how abundant it is, “structure”, which describes how the units are organised in space and time, and “function”, which describes the roles these different units play in maintaining ecosystem processes and dynamics (Maree *et al.*, 2006). All of these were taken into account during the prioritisation process.

According to the WET-Prioritise guideline (Rountree *et al.*, 2007) **prioritisation** “...implies ranking or valuing one above another such that those with a higher rank or value are by definition regarded as more important than those with a lower rank or value.” This broad definition was the basis for the prioritisation protocol applied for this project.

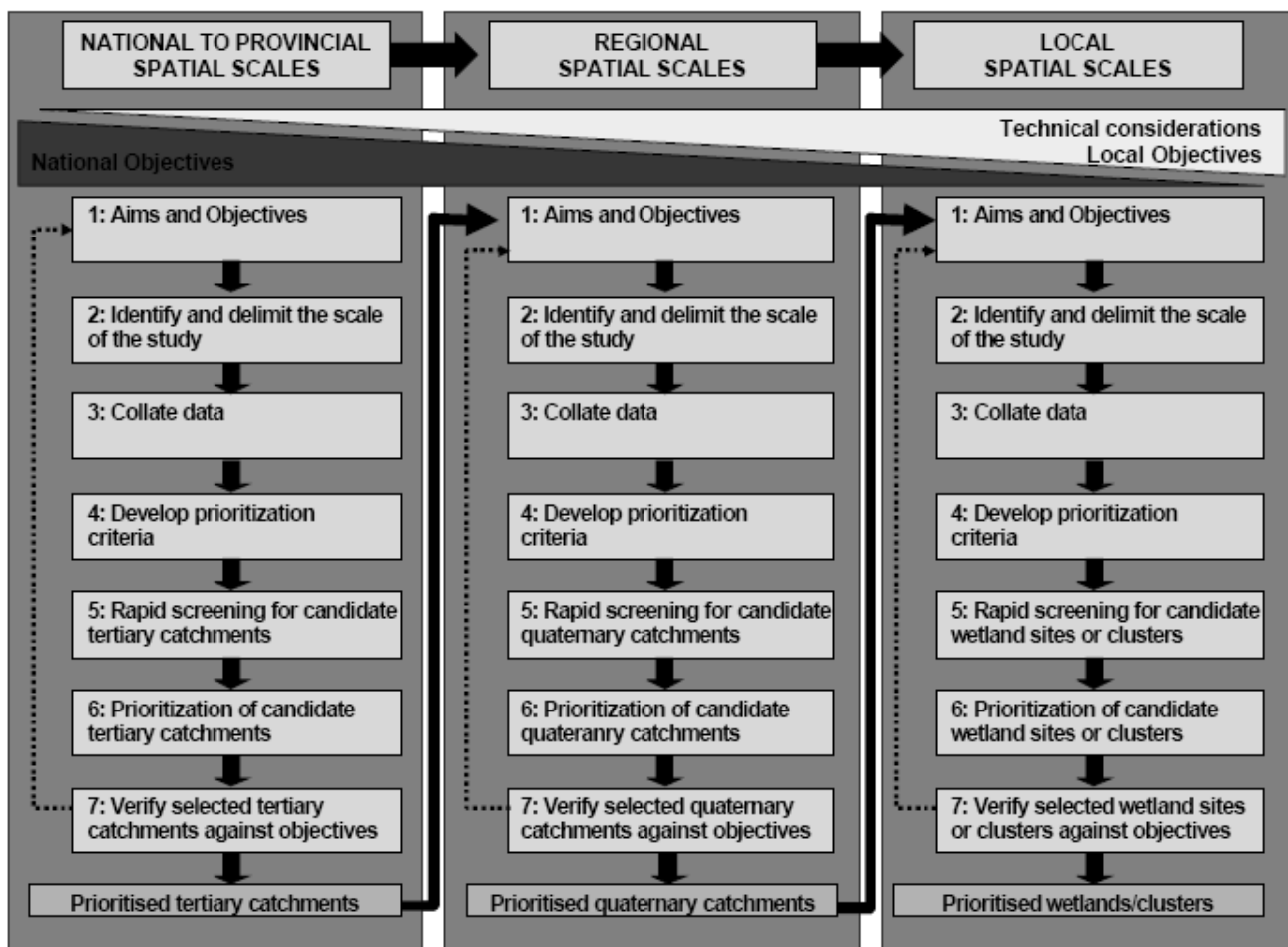


Figure 1 Prioritisation of wetlands at various spatial scales. Figure taken from Rountree et al. (2007).

### 1.5 Data format

The projection system used by the city is Transverse Mercator, Lo 19, based on WGS84. All spatial data inputs were therefore projected as WGS84, Lo19.

### 1.6 Project Reference Group

A reference group of an additional three experts was established, for review of work and critical discussion of key concepts. This group included Geordie Ractliffe (FCG), Dr Jenny Day (Freshwater Research Unit, UCT) and Barrie Low (COASTEC).

## 2 PRIORITISATION PROTOCOL

The process of prioritisation requires "...ranking or valuing one above another such that those with a higher rank or value are by definition regarded as more important than those with a lower rank or value. The ranking or value ascribed per resource or wetland unit would be highly dependent on the objectives of the

prioritisation process being undertaken” (quote taken from WET-Prioritise, Rountree *et al.*, 2007). The objective of the prioritisation of City wetlands was to rank or value wetlands according to their contribution to the conservation of biodiversity pattern and process. Thus, the recommendation of a set of Critical Biodiversity Areas (CBAs) – specifically of CBA wetlands – as required for Bioregional Plans, focused on high-ranking, natural or semi-natural wetlands.

Our approach was modelled on the process described and recommended in the WET-Prioritise manual, adopting the appropriate steps for prioritisation at the **local** spatial scale (see Figure 1), but also adding a few additional steps, in order to meet the City’s terms of reference. More detail on each step in the prioritisation protocol is provided in the sections that follow.

## **2.1 Step 1: Define the aims and objectives for prioritisation and the spatial extent of the study area**

The definition of the aims and objectives, and the spatial scope of the work, was carried out at a project initiation meeting with City personnel on 19<sup>th</sup> February 2009. It was confirmed that the main objective of the project is the conservation of wetland biodiversity pattern and process, within the City of Cape Town.

The spatial extent of the study area for prioritisation was defined as all wetlands lying within the City of Cape Town boundary, and including those wetlands that straddle the boundary. All mapped wetlands were retained on the City Wetlands Map, but those lying outside the City boundary were described as such in the “CBA\_cat” (CBA category) and “EXP\_CBA” (expert reviewed CBA category) attribute fields (see Table 6). In addition to natural and semi-natural wetlands, wetlands considered to be artificial were included in the prioritisation process. Artificial wetlands do provide important and valuable wetland habitat, but these wetlands were not considered to be Critical Biodiversity Areas, but could be considered to be Ecological Support Areas (see Section 2.3).

In order to ensure that the functional unit (i.e. more or less, the dominant hydrogeomorphic unit) of a wetland was considered for prioritisation, rather than smaller, sub-units, wetlands that were mapped as many polygons were reduced to fewer polygons, which represented the main functional wetland types within each wetland. For instance, the detailed mapping for Rietvlei was reduced to a merged polygon representing those floodplain flats in closer hydrological contact with the Diep River channel, and another representing the floodplain flats further from the river. In addition, one polygon comprised the artificially deepened area of the Rietvlei sporting area.

## **2.2 Step 2: Collate all available data**

A number of input data layers were required, which were used to describe and assess the biodiversity value of wetlands within each wetland type. These data provided information on both biodiversity pattern and processes.

### **2.2.1 Wetland location and approximate extent**

The prime source of data for prioritisation was the City Wetlands Map, as produced by and described in Ewart-Smith *et al.* (2008). The natural and semi-natural wetlands on the Map were partially (approximately 8%) ground-truthed (see Snaddon *et al.*, 2009) for wetland presence (not extent). The Map was found to be approximately 75% accurate overall, in terms of mapping wetland presence, with the accuracy of mapping of

the various wetland types ranging widely from 100% down to 39%. The mapping of the sandstone fynbos seeps and shale renosterveld depressions was found to be the least accurate, at close to 40% accuracy. Dune strandveld depressions were 55% accurate. Overall, however, the Map was considered to be sufficiently accurate as to allow for the systematic prioritisation of wetlands.

The current extent or size of each wetland was mapped to the outermost boundary of whichever distinguishing feature was used to map the wetland on the aerial photograph, generally the presence of wetland vegetation. Thus, this should capture the extent of maximum inundation, but also of saturation, i.e. the wetland boundary should lie along the edge of the temporary zone. Obviously, however, these visual cues are difficult to see on the aerial photographs, thus wetland extent or size is approximate. The actual extent of the temporary zone around a wetland can only be ascertained in the field using soil and vegetation indicators, as recommended in DWEA's Wetland Delineation Manual (DWAF, 2005).

### **2.2.2 Wetland type**

In the development of the City Wetlands Map, the primary objectives were the identification and mapping of the rough extent of wetlands. A secondary objective was the capture of as much attribute information as possible within the constraints of a visual interpretation of orthophotos, as well as existing, easily available information, and within the constraints of the time and budget allocated to the project. The desktop classification of wetlands was undertaken up to Level 4 of the draft NWICS of Ewart-Smith *et al.* (2006, and see Ewart-Smith *et al.* (2008) for more detail on the draft NWICS). Briefly, the NWICS is hierarchical, dividing wetlands into increasingly refined categories at four levels. Level 1 of the classification identifies broad categories of Systems, further subdivided into Subsystems (Level 2 of the classification). At the third level in the hierarchy attributes such as landform and setting, which determine the nature of water movement through wetland ecosystems, are used to discriminate additional wetland categories, called Functional Units. Finally at Level 4, discriminators such as dominant cover and life-form define "Structural Units". Ground-truthing of the City Wetlands Map found that the accuracy of wetland typing, at the Functional Unit (Level 3) level was approximately 95% accurate. The draft NWICS has recently been updated and refined, and is now referred to as the National Wetland Classification System (SANBI, 2009). Although the hierarchical levels of the new classification system differ from the draft NWICS, most of the Functional Units used for the City Wetlands Map correspond with the hydrogeomorphic types of Level 4A of the proposed for the NWCS. The exception to this is basin seep, which is no longer a type of wetland – seeps are now either hillslope seeps (on slopes) or valleyhead seeps (on valley floors<sup>1</sup>). This change will not hamper the description of wetland types within the City, however, as hillslope and basin seeps are grouped as seeps.

In addition to the classification of wetlands according to the draft NWICS, it was proposed that the City's wetlands be grouped into wetland types, which could be based on the classification according to NWICS and an appropriate environmental descriptor. In doing so, the full complement of wetlands in the City can be described in terms of the types of wetlands occurring there. The assumption is that landform shape, and setting (i.e. gradient and position in the landscape) determine the nature of water movement into, through, and out of a wetland, and the functions that the wetland is able to provide. Typing wetlands based on how they function (i.e. the functional units of NWICS), focuses attention on the functions that wetlands of a specific type are most likely to perform, while the landscape and ecosystem factors (such as vegetation group) are most likely to influence how wetlands of that type function. It is useful to identify the geographic

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<sup>1</sup> the typically gently sloping, lowest surface of a valley. For the purposes of the classification system, valley floors exclude areas situated between two valley sideslopes with a gradient of 0.1 or more (i.e.  $\geq 1:10$ ). The valley floor typically has a gradient of between 0.001 and 0.1 (i.e. 1:1000 to 1:10), although in certain situations (such as coastal areas with major dune systems) a valley floor may have a gradient of less than 0.001 (i.e. characteristic of the lowland subregion) (from SANBI, 2009).

areas in which the factors that influence wetland function (i.e. the ecosystem drivers) are similar, in order to ensure that wetlands that respond to these influences in similar ways are grouped together. This was found to be useful as a means of designing the ground-truthing process in Phase 5, so that wetlands from as many types as possible could be visited. Wetlands from 26 of the total 36 proposed wetland types were visited during ground-truthing.

The typing of wetlands assumes even greater significance for prioritisation. In applying a set of ranking criteria, it is imperative that wetlands of a similar type be compared against each other. During the ranking of wetlands, it was realised that isolated and non-isolated wetlands function in a very different manner, and should not be typed together. The 36 wetland types proposed for the ground-truthing phase were increased to 54 types in order to split isolated from non-isolated systems – this applied to seeps and depressions. The new classification system does not differentiate between isolated and non-isolated wetland systems as such – the presence of surface drainage in and out of wetlands is described slightly lower down the new classification hierarchy in Levels 4C and 4D. The City Wetlands Map may need to be adjusted to reflect this change.

With the exception of concrete reservoirs, wetlands considered to be artificial – i.e. those that have been categorised as such in any City database, or which clearly appear to be man-made (see Table 6 for the categories of artificial wetlands) – were also typed according to the rules described above. Reservoirs were categorised as “reservoirs”.

More detail on the City’s wetland types is provided in Appendix 1.

**Table 1 A list of the 54 wetland types within the City of Cape Town, providing data on the number of wetlands within each type, the area covered by each type, and the number of wetlands that are considered to be artificial.**

	<b>Wetland type</b>	<b># wetlands</b>	<b>total area (ha)</b>	<b># wetlands (&amp; %) that are artificial</b>
1	<b>Alluvium fynbos isolated depression</b>	75	41.9	71 (95%)
2	<b>Alluvium fynbos depression</b>	61	56.1	61 (100%)
3	<b>Alluvium fynbos floodplain</b>	7	6.6	1 (14%)
4	<b>Alluvium fynbos isolated seep</b>	19	16.1	2 (11%)
5	<b>Alluvium fynbos seep</b>	40	88.9	0 (0%)
6	<b>Alluvium fynbos valley bottom</b>	7	43.6	0 (0%)
7	<b>Alluvium renosterveld valley bottom</b>	1	0.7	0 (0%)
8	<b>Dune strandveld isolated depression</b>	1358	1436.2	712 (52%)
9	<b>Dune strandveld depression</b>	40	177.7	22 (55%)
10	<b>Dune strandveld floodplain</b>	163	751	2 (1%)
11	<b>Dune strandveld isolated seep</b>	139	318.6	6 (4%)
12	<b>Dune strandveld seep</b>	26	84.8	0 (0%)
13	<b>Dune strandveld valley bottom</b>	26	60.8	0 (0%)
14	<b>Granite fynbos isolated depression</b>	75	31.5	66 (88%)
15	<b>Granite fynbos depression</b>	125	120.7	123 (98%)
16	<b>Granite fynbos floodplain</b>	29	216	0 (0%)
17	<b>Granite fynbos isolated seep</b>	77	63.5	0 (0%)

	Wetland type	# wetlands	total area (ha)	# wetlands (& %) that are artificial
18	Granite fynbos seep	195	375.9	0 (0%)
19	Granite fynbos valley bottom	76	148.7	2 (3%)
20	Granite renosterveld isolated depression	40	25	38 (95%)
21	Granite renosterveld depression	52	47.6	51 (98%)
22	Granite renosterveld floodplain	1	2.4	0 (0%)
23	Granite renosterveld isolated seep	7	6.2	0 (0%)
24	Granite renosterveld seep	25	54.1	0 (0%)
25	Granite renosterveld valley bottom	18	80.8	0 (0%)
26	Sand fynbos isolated depression	1559	978.3	1113 (71%)
27	Sand fynbos depression	259	907.5	215 (83%)
28	Sand fynbos floodplain	117	809.7	6 (5%)
29	Sand fynbos isolated seep	340	702.2	10 (3%)
30	Sand fynbos seep	116	212.7	5 (4%)
31	Sand fynbos valley bottom	84	313.4	1 (1%)
32	Sandstone fynbos isolated depression	59	22	21 (36%)
33	Sandstone fynbos depression	28	74.5	28 (100%)
34	Sandstone fynbos isolated seep	416	230.3	0 (0%)
35	Sandstone fynbos seep	424	485.9	0 (0%)
36	Sandstone fynbos valley bottom	105	330.4	1 (1%)
37	Shale band seep	5	17.1	0 (0%)
38	Shale fynbos isolated depression	32	16.7	32 (100%)
39	Shale fynbos depression	17	669.6	17 (100%)
40	Shale fynbos valley bottom	11	21.2	0 (0%)
41	Shale renosterveld isolated depression	332	124.8	306 (95%)
42	Shale renosterveld depression	226	185	211 (93%)
43	Shale renosterveld floodplain	33	173.3	1 (3%)
44	Shale renosterveld isolated seep	87	129.7	1 (1%)
45	Shale renosterveld seep	122	237.3	7 (6%)
46	Shale renosterveld valley bottom	69	318.3	0 (0%)
47	Silcrete renosterveld isolated depressions	8	6.3	8 (100%)
48	Silcrete renosterveld depression	6	2.2	6 (100%)
49	Silcrete renosterveld isolated seep	3	1.8	0 (0%)
50	Silcrete renosterveld seep	3	1.6	0 (0%)
51	Silcrete renosterveld valley bottom	2	2.7	0 (0%)
52	Cape estuarine channel	12	106	1 (8%)
53	Cape estuarine depression	21	196.7	3 (14%)
54	Cape river mouth	9	23.2	0 (0%)
<b>TOTALS</b>		7187	11 555.8	3150 (44%)

### 2.2.3 Wetland condition

A rapid method for field assessment of wetland condition was devised during the ground-truthing phase, based on existing methods including WET-Health (MacFarlane *et al.*, 2005) and the Wetland Index of Habitat Integrity (DWAf, 2007). Similar to the WET-Health assessment, the impacts affecting each wetland were divided into four categories – modifications to the **vegetation** in and around (up to 50m) the wetland,

**physical** modifications to the wetland (e.g. those affecting the geomorphology or extent of the wetland), and modifications to **water quality** of the wetland and **water quantity** in and / or out of the wetland. Each impact category was given a percentage score – where 0 is no impact and 100% means complete modification of that aspect of wetland condition – which relates to the magnitude of the impact or stressor. The magnitude of the impact is a combination of the extent and intensity of the impact (MacFarlane *et al.*, 2005). The magnitude of each specific impact was scored, or where this was difficult to disaggregate, the specific impacts were scored collectively for the impact category. In order to summarise the impact scores, the scores for impacts were summed and averaged, and the total subtracted from 100% (this is the benchmark), in order to place the wetland in a habitat integrity class (or category, see Table 2) (see MacFarlane *et al.*, 2005). The habitat integrity of a wetland is a measure of the degree of intactness of that wetland.

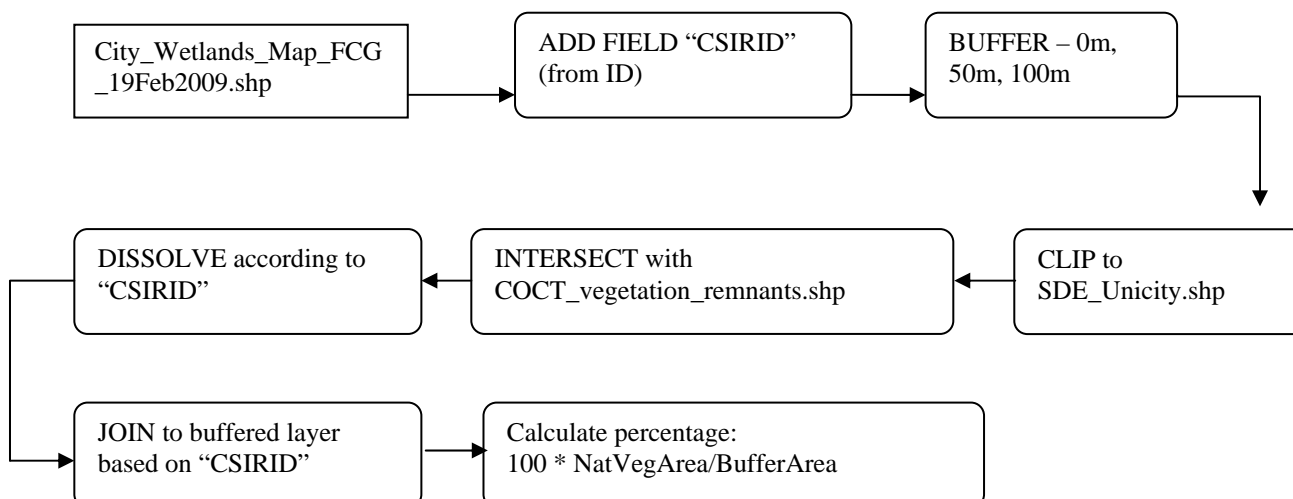
**Table 2 Wetland habitat integrity classes (based on Kleynhans, 1996).**

CLASS	DESCRIPTION	SCORE (% OF TOTAL)
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80-90
C	Moderately modified. A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	0

Where condition was not ground-truthed, this was modelled by Jeanne Nel and Ashton Maherry of the CSIR, Stellenbosch. Their methods are summarised below.

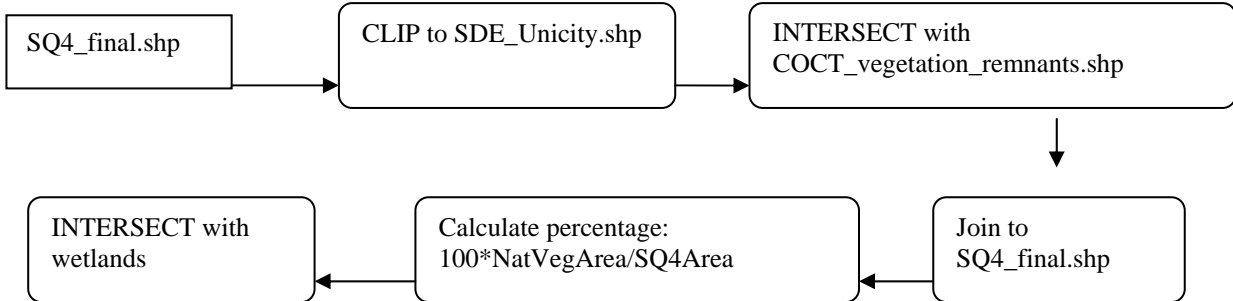
The % of natural vegetation was calculated within each wetland polygon, and within the wetland plus 50m and 100m buffers. The data layer "COCT\_vegetation\_remnants.shp" was used as an indication of the presence of natural vegetation. The % natural vegetation within the wetland, 50m and 100m buffers was calculated in EXCEL. The following condition classes were assigned:

- AB (>= 75% natural land cover);
- C (25-75% natural land cover), and
- Z (< 25%).

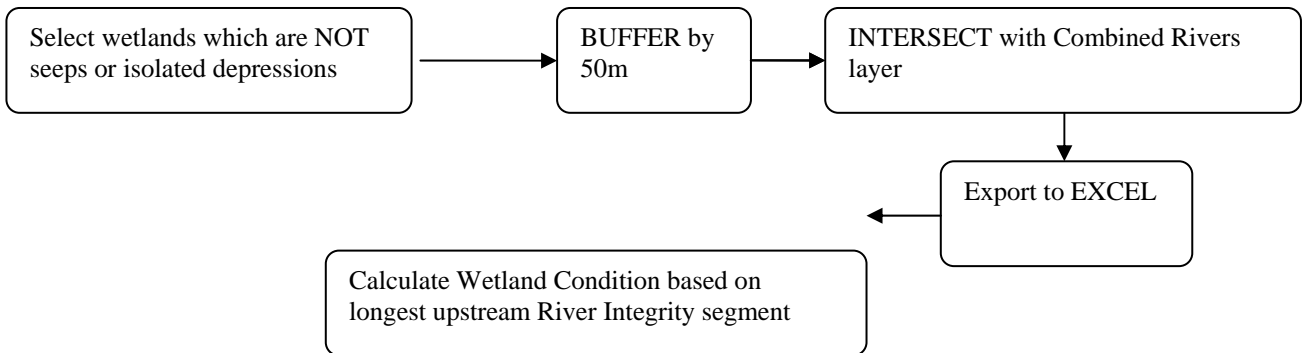


In addition to an assessment of the presence of natural vegetation within and around the wetland, a similar process was followed to calculate the % natural vegetation within each wetland’s sub-catchment. The sub-catchments modelled for the National Freshwater Ecosystem Priority Area (NFEPA) project were used,

where sub-catchments were modelled using a combination of digital elevation data (US SRTM 90m)<sup>2</sup> and the DWEA 1:500 000 rivers GIS layer. Where a wetland straddled multiple sub-catchments, a method in Excel was used to return the % natural vegetation based on the largest wetland area within each sub-catchment. This was double checked in Excel.



The condition of wetlands connected to rivers is also likely to be reflected in the condition of the river entering (or flowing through) the wetland. River integrity was assessed by Day *et al.* (1999), and the data provided to the City as a spatial layer. The City rivers database, “merge\_rivers.shp”, was used with “RCLPESC” as the river integrity field. This was augmented by the CSIR’s 1: 500 000 river integrity layer. Where integrity values were missing, the upgradient polyline integrity was used. Where no integrity values existed, “Z” was used.



In selecting the most appropriate wetland condition class for each wetland polygon, the following rules were applied:

- For seeps and isolated depressions: based wetland condition on minimum % natural vegetation only, where AB >= 75% natural vegetation; C = 25-75% natural vegetation and Z < 25%.
- For all other wetlands: if majority river integrity of the upstream river segment is D, E or F, then base wetland condition on majority river integrity. Where wetlands are associated with A, B or C rivers, then base condition on minimum % natural vegetation only, where AB >= 75% natural vegetation; C = 25-75% natural vegetation and Z < 25. This rule will also apply to wetlands where river integrity is not known.

<sup>2</sup> available from the website: <http://www.personal.psu.edu/users/j/z/jzs169/Project3.htm>

A second surrogate for wetland condition was used – this was the condition of the surrounding natural vegetation, which was extensively ground-truthed for the City’s Biodiversity Network. The habitat condition classes are provided in Table 3.

**Table 3 Definition of categories for habitat condition in City’s Biodiversity Network ground-truthing field sheet.**

Category	Explanation
High/ natural	Vegetation is largely intact with all structural elements present and evidence of moderate to high species richness and compositional integrity; soil seed banks are intact and alien cover is low to dense (i.e. no large closed-canopy stands of aliens). Red Data species evident.
Medium/ near natural	Vegetation is altered with some structural elements (e.g. the overstorey shrub layer) missing; low to moderate species richness; soil seed banks likely to be partially depleted; alien cover is low to closed-canopy
Low/ restorable	Vegetation structure is altered with many key elements missing (e.g. mainly weedy, herbaceous species remain owing to frequent brush cutting, fires, ploughing or long-invasion); soil seed banks largely depleted (little evidence of geophytes); alien cover is low to closed-canopy
Transformed	Land has been transformed by housing or other development so that vegetation structure and soil-stored seed banks are largely destroyed and not restorable

#### 2.2.4 Connectivity

Wetlands do not function in isolation from processes that are occurring around them. Wetlands are possibly linked to groundwater resources (vertical connectivity), rivers (longitudinal connectivity) and to each other across dry land (lateral connectivity). It cannot be assumed that a wetland that is more likely to be linked to other surface or sub-surface systems is more valuable, in terms of conservation, than a wetland that is isolated from these systems. However, by conserving systems that are connected with others, the assumption is that more complex, inter-linked ecological processes are more likely to be conserved. Furthermore, where these links are in good condition, ecological processes are more likely to be maintained. For instance, the natural processes of sediment and/or nutrient transport are more likely to be maintained where good condition wetlands are connected by good condition river reaches.

It is important to realise that non-isolated systems were never compared against isolated systems, as the ranking of wetlands occurred **within** wetland types and not between them.

In order to assess the complexity and condition of these linkages, the following databases were used:

- **Condition of the up- and downstream river reaches:** non-isolated wetlands in the vicinity (up to 50m distant) of good condition (Class C or higher) river reaches, as recorded in the City’s rivers database (“merge\_rivers.shp”) and assessed by Day *et al.* (2000), were considered to be “more connected” than those in the vicinity of poor condition (Class D or lower) river reaches. Unfortunately, many of the rivers of the City lack condition or integrity data, and so wetlands surrounding good condition rivers not on the map could not be assessed for this criterion. However, this was only an issue for non-isolated systems in the Table Mountain National Park area, and these wetlands scored high for several other criteria.
- **Location of wetland clusters:** isolated seeps and depressions were examined to see where they occur in clusters. Wetlands were considered to be clustered together where the distance between wetlands was less than 100m. This distance is arbitrary and fairly small – in other similar assessments (see Snaddon *et al.*, 2008) the distance between clustered wetlands is usually 750m, which is half the distance across which amphibians are likely to move between wetlands. However, in the urban environment, this distance is probably less due to the replacement of open areas with hardened development and

infrastructure. Wetland clusters were considered to be significant if their size exceeded 100 hectares, and they incorporated at least 10 wetlands of varying sizes.

- **Condition of the surrounding vegetation:** The likelihood of terrestrial connectivity between wetlands will be strongly influenced by the condition of the vegetation. For this assessment, the % natural vegetation within the surrounding sub-catchment was used as a measure of terrestrial connectivity.

### 2.2.5 Supporting species

All relevant, systematic biophysical data on the wetlands of the City were collected, as far as possible. This included the fish and amphibian data housed at SAIAB and / or CapeNature, floral and faunal data supplied by the City, and plant data, supplied by CREW and the Protea Atlas Project. As far as we know, there is no systematic database on wetland characteristics such as invertebrates, water quality and hydroperiod.

The following databases were used:

- CREW data: all plants listed in and around (up to 50m) wetlands
- Protea Atlas Project: only endangered species listed in and around (up to 50m) wetlands
- Frog data: locations for Cape Caco (*Cacosternum capense*), Table Mountain Ghost Frog (*Heleophryne rosei*), Microfrog (*Micobatrachella capensis*), breeding sites for the Western Cape Leopard Toad (*Amietophrynus pantherinus*).
- Bird data: important bird areas (IBAs), active heronries
- Fish data: important fish nurseries.

Although the following information could not be used due to the current inconsistency of the data, the following notes were made during a meeting with Dean Impson of CapeNature as part of the CBA review process. These notes have relevance in terms of catchment management and the conservation of wetlands **and** rivers, in the City of Cape Town. Where relevant, these comments were taken into account during expert review of the CBA wetlands. The lack of complete datasets for Cape Town highlights the need to fill this information gap.

- Rietvlei is important as a fish nursery, but less so than Zandvlei.
- Zandvlei is marine dominated, which controls the invasion of alien fish species such as carp (*Cyprinus carpio*) and sharptooth catfish (*Clarias gariepinus*).
- Cape Kurper (*Sandelia capensis*) occur in the Diep River, as far north as Malmesbury, where they are uncommon to rare. They also occur in the Kuils, Liesbeeck, Keysers and Lourens rivers. There may be more than one evolutionarily significant unit (ESU) in the City of Cape Town.
- Cape Galaxias (*Galaxias zebratus*) occur across the City of Cape Town, and there is more than one ESU in the area – the Eerste River has more than one ESU. Their locations are not all known. They do occur in the Bokramspruit, above Ocean View, at the top of the Bottelary River catchment, and in the Silvermine River. More work is needed on this species.
- The longfin eel (*Anguilla mossambica*) has been caught in the Lourens River, but it probably also occurs in the Eerste River.
- The Berg River redbfin (*Pseudobarbus bergii*) used to occur in the Eerste River, but is now locally extinct. Now only the Breede River redbfin (*Pseudobarbus burchelli*) occurs in this system, introduced below Kleinplaas Dam at Jonkershoek.

### **2.2.6 Sensitivity to change**

The sensitivity of a wetland to changes in water quality and quantity can be used as a means of assessing conservation importance. Due to a lack of comprehensive data on hydroperiod, sensitivity to changes in water quantity, where the assumption is made that non-permanent systems are more sensitive than permanent systems, could not be assessed. In order to assess sensitivity to change in water quality, it was assumed that wetlands lying on acid soils in natural vegetation remnants are more sensitive than those on alkaline or neutral, or on transformed soils. The City vegetation map was used to locate wetlands lying on acid soils, based on the vegetation type, and the vegetation remnants map was used to locate transformed versus untransformed areas.

## **2.3 Step 3: Derive ranking criteria and protocol**

The selection of a set of ranking criteria was initiated at a workshop organised by the Western Cape Wetlands Forum (WCWF) in November 2008. A brief review of the literature was undertaken prior to the workshop in order to be able to present a proposed set of criteria for discussion. Participants at the workshop largely accepted the proposed list of criteria and added a few more (see Workshop Report, WCWF, 5 November 2008). The complete list of criteria was as follows:

- Wetland condition;
- Wetland size;
- Sensitivity, importance (in terms of contribution to local, regional and national biodiversity, but also in terms of the provision of ecosystem goods and services (not socio-economic services)) and level of threat (i.e. vulnerability, plus could take into account surrounding land-use and potential for protection);
- Location with regard to springs, groundwater recharge or discharge areas;
- Proximity to other wetlands, estuaries and rivers in good condition;
- Surrounding land-use, and condition of terrestrial vegetation;
- Presence of fish or amphibian species;
- Location with regard to the City's Biodiversity Network;
- Rehabilitation potential;
- Practicality of actively protecting / conserving wetland (e.g. in a reserve) ;
- Condition of wetland buffer, and
- Location with regard to special features, such as biological or geomorphological features

In order to undertake a systematic comparison between wetlands of the same type, it was necessary to have data that could be spatially linked to all of the mapped wetlands. Table 4 provides the final set of criteria that could be used within the limits of this constraint (see Section 2.2 for a discussion of the available data). A number of criteria were also rejected as being inappropriate for ranking wetlands, but useful for the integration of the prioritised Wetlands Map with the Biodiversity Network. For example, criteria that assess the practicality of protection of a wetland, such as location with regard to the Network, and the location of currently protected areas, will be used in the selection of parcels of land for conservation that achieve a number of conservation goals including practicability. Furthermore, the use of rehabilitation potential as a ranking criterion was not used for wetland ranking, as the objective of this wetland prioritisation was conservation and not rehabilitation.

The final set of criteria was weighted (see Table 4), using expert opinion, according to how effectively each criterion assesses the biodiversity value of a wetland. Thus, wetland condition was deemed to be the most effective criterion, and wetland size the least effective (i.e. smaller wetlands are not necessarily less diverse than larger wetlands).

**Table 4 The list of the criteria used for the ranking wetlands within each wetland type. Each criterion was weighted according to how effectively it assesses the biodiversity value of the wetland. Wetlands were scored against each criterion, with 5 being the highest score and 0 the lowest.**

Criterion	Weighting (%)	5	3	1	0	Max score possible
<b>Modelled wetland condition</b>	100	A AB B	B/C C C/D D	D/E E F Z		<b>5</b>
<b>Terrestrial habitat condition</b>	100	≥ 50% natural vegetation in <b>high</b> condition	≥ 50% natural vegetation in <b>medium</b> condition  < 50% vegetation in <b>high</b> condition	< 50% in <b>medium</b> condition  any % in low condition	Transformed  Not with any vegetation remnants	<b>5</b>
<b>Sensitivity to changes in water quality</b>	100	Remnant vegetation types on acid soils		Remnant vegetation types on neutral or alkaline soils	Transformed	<b>5</b>
<b>Supporting species</b>	80	At least 1 Red Data Book species (flora or fauna); Breeding sites; Fish nurseries; Important Bird Areas	Heronries		None	<b>4</b>
<b>Terrestrial connectivity</b>	80	> or = 75% natural vegetation in the sub-catchment	25 – 74% natural vegetation in the sub-catchment	< 25 % natural vegetation in the sub-catchment		<b>4</b>
<b>Naturalness</b>	80	natural or semi-natural	stormwater depressions  stormwater ponds	dams WWTW ponds and effluent ponds  irrigation ponds	reservoirs  marinas quarries	<b>4</b>

Criterion	Weighting (%)	5	3	1	0	Max score possible
<b>Aquatic connectivity</b>	60	Wetlands that are connected to an estuary (within 50m, and non-isolated, and excluding WWTW ponds), all estuaries, wetlands that are connected to good condition river (within 50m of Class C or higher (from City "merge rivers", PLUS CSIR's incoming river condition), or obviously linked with good condition rivers (e.g. in the mountainous areas) and non-isolated, and including artificial waterbodies (except reservoirs))	Within a significant wetland cluster (isolated systems only completely contained within significant (>100ha) wetland cluster (based on min 100m buffered distance between wetlands))	Connected to poor condition river (within 50m of Class D, E, F (from City's "merge rivers" PLUS CSIR's downstream river condition), and non-isolated, and including artificial waterbodies (except reservoirs))	Isolated from any other surface freshwater system, or connected to a canal; all open reservoirs	<b>3</b>
<b>Wetland size</b>	40	> 5 hectares	> 2 – 5 hectares	≤ 2 hectares		<b>2</b>
<b>Max total score possible if all criteria apply</b>						<b>32</b>

Scores were assigned to each of the criteria in Table 4, based on how each wetland "performs" against the criterion. The allocation of scores to each criterion allowed the quantification of, in some cases, qualitative information about each wetland. The choice of scores was fairly arbitrary, where the highest score was 5, and the lowest, 0.

The total score was calculated as follows, taking into account the weighting of each criterion:

$$[\text{Wetland condition}] + [\text{Terrestrial habitat condition}] + [\text{Sensitivity to water quality change}] + (80/100 * [\text{Terrestrial connectivity}]) + (80/100 * [\text{Naturalness}]) + (80/100 * [\text{Supporting species}]) + (60/100 * [\text{Aquatic connectivity}]) + (40/100 * [\text{Wetland size}]) = \text{TOTAL SCORE}$$

All of the criteria could be applied to every wetland. However, some wetland types could not score a perfect score for all criteria, for example, isolated wetland systems could not score a "5" for aquatic connectivity, but could score a "3" if they are within a significant wetland cluster.

This approach is similar to that implemented by Ausseil *et al.* (2007), in their rapid mapping and prioritisation of wetland sites in New Zealand. Their criteria included representativeness, wetland area, surrounding naturalness, and connectivity. Each of their criteria was weighted and the results summed for each wetland.

## 2.4 Step 4: Rank City wetlands and assign wetlands to biodiversity categories

Two approaches were used for the final ranking of wetlands:

**City-wide ranking:** The first approach was to use the maximum possible score for all criteria as the benchmark for ranking. This approach allowed for the identification of wetlands that are considered to be of high biodiversity value, as assessed by the criteria in Section 2.3, within the context of wetland biodiversity in the City of Cape Town. This method does not take into account the fact that there are wetland types that will never achieve the maximum score, as there are few or no wetlands that remain in a good condition, or that maintain good connectivity, etc. This approach will not identify wetlands that are the “best” remaining examples of a particular wetland type, but will identify the best remaining wetlands in the City.

**Ranking within each wetland type:** The second approach uses the highest score obtained within the wetland type as the benchmark for ranking. This method identifies the best remaining wetlands of a particular type.

For both methods, ranking bands were allocated as follows:

- Wetlands scoring in the highest quarter (> 75% of the highest total) of scores were ranked 1;
- Wetlands in the second quarter (>50% and ≤75%) were ranked 2;
- Wetlands in the third quarter (>25% and ≤50%) were ranked 3, and
- Wetlands in the last quarter (≤25%) were ranked 4.

The wetlands were assigned to proposed aquatic biodiversity categories as follows:

- **Critical Biodiversity Areas:** High ranking “natural or semi-natural” wetlands within each type (top quarter of total scores = CBA1 (rank 1); second quarter = CBA2 (rank 2)); all estuaries (top quarter of total scores = CBA1; remaining estuaries = CBA2);
- **Critical Ecological Support Areas:** High ranking artificial wetlands (top quarter of artificial wetlands) (rank 1); middle ranking natural or semi-natural wetlands (third quarter of total scores) (rank 3), and
- **Other Ecological Support Areas:** Lower ranking artificial wetlands (ranks 2, 3 and 4); lowest ranking natural or semi-natural wetlands (rank 4).

These aquatic biodiversity categories are similar to those applied to the terrestrial spatial layer (Table 5), but are not necessarily equivalent. There is insufficient data on the historical extent of wetlands in the City to be able to gain an understanding of the irreplaceability of wetlands. Thus, biodiversity categories were assigned to wetlands based on their ranking, as discussed above. For example, the aquatic CESA’s are middle ranking natural wetlands and high ranking artificial wetlands, and are not wetlands that are considered important for connectivity or as support areas for CBA wetlands.

The integration of aquatic and terrestrial spatial layers will probably lead to a different categorisation of wetlands, based on their location in relation to or connectivity with terrestrial features.

**Table 5 The City of Cape Town's biodiversity categories, as defined for the terrestrial Biodiversity Network.**

<b>CBA category</b>	<b>CBA name</b>	<b>Description</b>
Protected	Conservation areas/sites	Protected Areas (National, Provincial, Local & Contractual Nature Reserves) and areas currently being managed as part of existing reserves or core flora sites, but which have no legal status as yet
CBA1a	Core Flora Sites	Irreplaceable Core Flora Sites
CBA1b	Irreplaceable High & Medium Condition Sites	Critically Endangered vegetation of High & Medium quality. Needed for national targets. Any loss is a permanent & irrevocable loss
CBA1c	Minset High & Medium Condition sites	High & Medium condition vegetation that is endangered or vulnerable & selected on the Biodiversity Network for meeting national targets (C-Plan). Loss can be replaced by obtaining specific Unselected Natural Vegetation Sites
CBA1d	Irreplaceable Consolidation Sites	Critically Endangered vegetation of restorable condition. Essential for management consolidation & viability of CBA 1a, CBA 1b & protected sites
CBA1e	Connectivity Sites	High & Medium condition vegetation that is endangered or vulnerable & selected on the Biodiversity Network for connectivity (using Marxan)
CBA2	Restorable Irreplaceable Sites	Critically endangered vegetation of restorable condition. Needed for national targets but not for management consolidation, connectivity or viability of priority Biodiversity network sites.
CESA 1a	Transformed sites of Conservation Significance	Transformed by agriculture or other activities. Essential for management consolidation, connectivity & viability of biodiversity elements in CBA 1a, CBA 1b & protected sites
Other Natural Vegetation	Unselected Natural Vegetation: High/Med/Restorable	Natural vegetation in Endangered, Vulnerable and Least Concern in good or restorable condition.

The draft map of CBA, CESA and OESA wetlands *within each wetland type* was presented to the City on 11<sup>th</sup> June 2009 for expert review, and to a number of other experts and organisations, including CapeNature and SANParks. The biodiversity categories were updated with the results of the review process.

## **2.5 Step 5: Link conservation and/or management objectives to each category of biodiversity features**

A set of ecosystem management guidelines was developed for each biodiversity feature – i.e. for each functional wetland type (down to the level 3 functional unit classification in the National Wetlands Inventory Classification System) / biodiversity category combination, such as CBA valley bottom wetlands, CBA floodplain wetlands etc. This was done for all wetland types within the CBA category and then for the wetland types within a combined ESA category, which can be applied to both CESA's and OESA's. The guidelines were adapted from those provided in the regional fine-scale conservation plans, and so are consistent with regional guidelines.

## **2.6 Step 6: Ground-truth sub-set of CBA wetlands**

A subset of the draft set of CBA wetlands was ground-truthed by City staff. The ground-truthing focused on those CBA wetlands that fall outside of proclaimed Protected Areas and are wetland types that were mapped with low confidence. A total of 68 wetlands were visited, 21 of which were deleted from the Map. The City Wetlands Map was updated to reflect the results of the ground-truthing.

## **2.7 Step 7: Produce final prioritised City Wetlands Map**

The City Wetlands Map was updated to include all information relating to the scoring of each wetland polygon, and the biodiversity category assigned to each wetland (based on ranking *within each wetland type*), both as a result of the ranking protocol, and subsequent to expert review. A number of wetlands were deleted, added or amended as a result of the ground-truthing done by City staff, as well as through ongoing checking of the map against current aerial photographs. The attribute fields included in the updated City Wetlands Map (FINAL\_City\_Wetlands\_FCG\_29Jul09.shp) are presented in Table 6.

**Table 6 Attribute fields of the updated City Wetlands Map.**

Abbreviation	Heading in full	Explanation	Attribute options	Attribute detail
WET_ID	Wetland identity	Unique identifier code / number for each wetland polygon for this project	various e.g. GR001	code is based on the initials of the mapper, plus numeric identifier for reference
WET_NAME	Wetland name	Name of wetland where it exists on topo map, existing GIS data or elsewhere	various e.g. Kuils R fldpl	gap or unknown represents unknown name, some abbreviations
MAP_SOURCE*	Information source for mapping and classification of a wetland	Main source of information used in the mapping and classification of the wetland	CCT pond 2003	based on CCT 2003 ponds layer
			CCT pond 2005	based on CCT 2005 ponds layer
			orthophotos	based on visual examination of orthophotos
			field assessment	based on field-assessment or study
			CCT waterbodies	based on description in CCT "waterbodies" layer
Confid_MAP	Confidence level – wetland mapping	Indicator of the confidence of the mapper in whether the polygon represents wetland habitat	high	reasonable certainty based on ground-truthing, field assessment or good visual cues
			low	mapper uncertain and the presence of wetland requires field verification
Transform*	Transformed wetlands	Description of the type of impact that has led to the probable transformation of most (more than 75%) or all of the natural or semi-natural wetland; all artificial wetlands are described as "artificial"	mowed	urban modification of wetland areas e.g. sports fields
			partially drained	wetlands retaining natural function but associated with drainage ditches
			farmed	range of modifications as a result of farming practices, e.g. ploughing
			afforested	wetlands transformed by plantations of woody exotic vegetation
			excavated	wetlands have clearly been significantly altered through excavation
			stormwater	wetlands have been modified through input of stormwater, from residential, industrial or agricultural areas
			developed	hard development (i.e. housing, roads, parking lots etc) have significantly reduced the extent and nature of the wetlands
			grazed	grazing has significantly altered the vegetation growing in the wetlands
			cleared	natural wetland vegetation has been cleared, but not necessarily replaced by crops (see "farmed")
			effluent	effluent from a waste water treatment plant has significantly altered the wetland characteristics
unknown	wetland may be transformed but transformation unknown			

Abbreviation	Heading in full	Explanation	Attribute options	Attribute detail
Artif_typ*	Type of artificial waterbody	Identification of one of a number of categories that define a range of artificial wetlands, and which are based on the descriptions in the source data, namely the City "waterbodies" or 2005 ponds update GIS covers	open reservoir dam quarry irrigation pond WWTW pond WWTW effluent pond stormwater pond stormwater depression marina none	concrete water reservoir specific category off CCT waterbodies layer specific category off CCT waterbodies layer specific category off CCT waterbodies layer, separate function to stormwater ponds includes irrigation and sludge ponds, no ecological value larger, shallower effluent ponds, may have ecological function general name given to stormwater, detention, retention and attenuation ponds in the CCT 2005 ponds update and CCT "waterbodies" layers open areas identified from orthophotos during this project – i.e. that are not registered in the existing City's GIS cover but appear to be artificial describes waterbodies created for marinas wetlands categorised as natural or semi-natural, generally retaining natural function, although may be impacted (i.e. not pristine)
WetCLASS_1	Wetland Classification Level 1: SYSTEM	Level 1 of the National Wetland Classification: major systems	estuarine inland	as described in the National Wetland Classification System
WetCLASS_2	Wetland Classification Level 2: SUB-SYSTEM	Based on tidal exchange (estuaries) or hydrological connectivity (inland systems)	permanently open temporarily closed isolated non-isolated	as described in the National Wetland Classification System ; not all wetland types were encountered in this project phase
WetCLAS_3a	Wetland Classification Level 3a: FUNCTIONAL UNIT	Based on landform features that determine hydrological and geomorphological processes.	N/A river mouth estuarine depression estuarine channel depression linked channel floodplain valley bottom seep, channeled outflow seep, no outflow	as described in the National Wetland Classification System ; not all wetland types were encountered in this project phase N/A = not applicable

Abbreviation	Heading in full	Explanation	Attribute options	Attribute detail
			isolated depression	
WetCLAS_3b	Wetland Classification Level 3b: Functional Sub-unit		N/A	as described in the National Wetland Classification System ; not all wetland types were encountered in this project phase N/A = not applicable
			with channel	
			without channel	
			meander cutoff	
			floodplain flat	
			floodplain pan	
			with channeled outflow	
			without channeled outflow	
			basin seep	
			hillslope seep	
			unknown	
WetCLAS_4a	Wetland Classification Level 4b: Structural Unit	depth class	N/A	As described in the National Wetland Classification System N/A = not applicable Some systems were allocated more than one attribute category
			limnetic	
			limnetic & littoral	
			littoral	
			subtidal	
			supratidal	
			unknown	
WetCLAS_4b	Wetland Classification Level 4b: Structural Sub-unit	Dominant cover type	N/A	As described in the National Wetland Classification System ; not all wetland types were encountered in this project phase N/A = not applicable Some systems were allocated more than one attribute category (e.g. both open water plus emergent vegetation in parts of a wetland)
			rocky/unconsolidated	
			open water	
			open water & emerg veg	
			surface/subsurface veg	
			emerg veg	
			unknown	
WetCLAS_4c	Wetland Classification Level 4c: Structural Sub-unit	Dominant substratum type or dominant life-form	N/A	Types as described in the National Wetland Classification System; not all wetland types were encountered in this project phase N/A = not applicable
			none	
			floating	
			rooted	
			herbaceous	

Abbreviation	Heading in full	Explanation	Attribute options	Attribute detail
			mixed	
			scrub-shrub	
			sand	
			silt/mud	
			unknown	
DOM_VEG	Dominant vegetation	Provides a list of genera or species, or plant growth form, dominating the wetland	various e.g. Bolboschoenus maritimus	
ALIEN_VEG	Alien vegetation	Provides a list of dominant alien genera or species, generally woody but also grasses	various e.g. A. saligna	
HydroPerio	Hydroperiod	Describes the frequency and level of inundation or saturation	perm inundated	data only captured where available; data sparse abbreviations: perm = permanent, seas = seasonal
			perm saturated	
			seas inundated	
			seas saturated	
			not permanent	
Salinity				data not captured – field included for future use
pH				data not captured – field included for future use
CONF_CLASS	Confidence level - wetland classification	Confidence in the classification of the wetland, according to NWICS (Ewart-Smith <i>et al.</i> , 2006)	low	
			moderate	
			high	
COMMENTS	Comments	Any additional comments or observations	various	Includes the reference, if wetland was ground-truthed or assessed during a consultancy project (see References for full citations)
Area_M2	Area (m <sup>2</sup> )	GIS-generated information		Area in m <sup>2</sup>
Area_ha	Area (ha)	GIS-generated information		Area in hectares
PHASE	City Wetlands Map Project phase	The project phase during which the wetland was added to the database	1	Phase 1 Mapping and classification
			2	Phase 2 Mapping and classification
			3	Phase 3 Mapping and classification
			4	Phase 4 Mapping and classification
			5	Phase 5 Ground-truthing
GR_TRUTHED	Ground-truthed?	Records whether a wetland was ground-truthed, either during Phase 5, or during other consultancy projects	Y	Yes; gap means the wetland was not ground-truthed
			Y – prior	Yes, wetland was ground-truthed during the prioritisation project (Phase 6)

Abbreviation	Heading in full	Explanation	Attribute options	Attribute detail
GRTRUTH_BY	Ground-truthed by	Name of the individual who ground-truthed the wetland	various, names of ground-truthers	Name and organisation
GRTRUTH_DAT	Ground-truthing date	Date on which the wetland was visited	various, e.g. 11/12/2008	
WET_COND	Wetland condition	Wetland condition Class, either modelled (see Section 2.2.3) or ground-truthed	A, B, C, D, E, F, Z	Class assigned according to DWAF (1999) protocol, with Z assigned to wetlands modelled as being in poor condition (i.e. <25% minimum natural vegetation)
CONF_COND	Condition confidence	Confidence with which wetland condition has been assessed	High, moderate, low	Confidence will be lower if upstream impacts are unknown, or if condition was modelled
IMPACTS	Impacts	Impacts affecting wetland condition, but not necessarily leading to transformation of the wetland	various, e.g. grazing	
LANDUSE100	Land-use within 100m of the wetland	Land-use within 100m of the wetland, listed in order of dominance	various, from field datasheet (see Appendix 1)	
LANDUSE1km	Land-use within 1km of the wetland	Land-use within 1km of the wetland, listed in order of dominance	various, from field datasheet (see Appendix 1)	
VEG_GROUP	Vegetation group	Vegetation group within which the wetland lies	As provided on the City vegetation map	
WET_TYPE	Wetland type	Wetland type, based on functional wetland type and vegetation group	e.g. sandstone fynbos isolated seep	54 wetland types (see Section 2.2.2)
NatVeg0m	% natural vegetation within the wetland	% natural vegetation within the wetland as a surrogate of wetland condition	%	0 – 100%
NatVeg50m	% natural vegetation within the wetland and 50m around the wetland	% natural vegetation within and surrounding (up to 50m) the wetland as a surrogate of wetland condition	%	0 – 100%
NatVeg100m	% natural vegetation within the wetland and 100m around the wetland	% natural vegetation within and surrounding (up to 100m) the wetland as a surrogate of wetland condition	%	0 – 100%
NatVegSq4	% natural vegetation within the sub-catchment surrounding the wetland	% natural vegetation within the sub-catchment (sub-quaternary) surrounding the wetland as a surrogate of wetland condition	%	0 – 100%
Min_NatVeg	Minimum % natural vegetation value	Minimum of the previous four values	%	0 – 100%
WetMajRivl	Condition class for river entering the wetland	Condition Class based on City's "merge river" database, or CSIR's national database	A, B, C, D, E, F	Class assigned according to DWAF (1999) protocol
SENSWQ_SC	Score given to each wetland describing its sensitivity to changes in water quality,	Wetlands on remnant acid soils were assumed to be most sensitive, scoring 5, and those on remnant alkaline and neutral soils are less sensitive, scoring	0 - 5	Score

Abbreviation	Heading in full	Explanation	Attribute options	Attribute detail
		1. Wetlands not on remnant vegetation score 0.		
AQCONN_SC	Score given to each wetland describing the aquatic connectivity of the wetland	All estuaries, and wetlands connected to estuaries and rivers in good condition (Class C or higher) score 5, those within significant wetland clusters score 3 and those connected to poor condition (Class D or lower) rivers score 1. Wetlands connected to canals score 0.	0 - 5	Score
TRRCONN_SC	Score given to each wetland describing the condition of the surrounding vegetation in the sub-catchment	A measure of the terrestrial connectivity between wetlands	0 - 5	Score
NATURAL_SC	Score given to each wetland describing the naturalness of the wetland	Natural or semi-natural wetlands score 5; stormwater depressions and ponds score 3; dams, WWTW ponds and effluent ponds and irrigation ponds score 1; and marinas and quarries score 0.	0 - 5	Score
SIZE_SC	Score given to each wetland describing the size of the wetland	Wetlands > 5 ha score 5; those between 2 and 5 ha score 3; and those ≤2 ha score 1	0 - 5	Score
SPECIES_SC	Score given to each wetland recording whether the wetland is known to support aquatic or semi-aquatic species of flora or fauna	Wetlands known to support at least 1 RDB plant or animal species, or to be an important bird area, Western Cape Leopard Toad breeding site or fish nursery score 5; those known to be important heronries score 3.	0 - 5	Score
COND_SC	Score given to each wetland describing its condition	Wetlands modelled or assessed as being in Class B or higher score 5; those in Class D to Class B/C score 3; and those below a Class D score 1.	0 - 5	Score
WETVEG_SC	Score given to each wetland describing the condition of the surrounding terrestrial vegetation	Based on the habitat condition of the terrestrial vegetation, as ground-truthed by the City for the Biodiversity Network	0 - 5	Score
TOT_SC_FIN	Total final score	Calculated as follows (see : [COND_SC] + [WETVEG_SC] + [SENSWQ_SC] +(80/100 *	1 - 32	Score

Abbreviation	Heading in full	Explanation	Attribute options	Attribute detail
		[TRRCONN_SC] +(80/100 * [NATURAL_SC] +(80/100 * [SPECIES_SC] +(60/100 * [AQCONN_SC] +(40/100 * [SIZE_SC])		
RANK	Rank provided to wetlands within each wetland type,	Rank is based on the final total score assigned to each wetland	1 – 4	Rank
NET_STATUS	Status of the Biodiversity Network	Status of the parcel of land within which the wetland lies	Protected CBA1a – 1e CBA2 CESA1a Other Nat Veg	See Table 5
CBA_cat	Biodiversity category assigned to the wetland	Draft biodiversity category (i.e. prior to integration with the terrestrial Network) based on the wetland's rank and naturalness	CBA1 CBA2 CESA OESA WWTW Outside COCT	Very high ranking (rank = 1) "natural or semi-natural" wetlands (and estuaries) within each type - top quarter of total scores High ranking (rank = 2) "natural or semi-natural" wetlands within each type - second quarter of total scores; all remaining estuaries High ranking (rank = 1) artificial wetlands - top quarter of artificial wetlands; middle ranking (rank = 3) natural or semi-natural wetlands - third quarter of total scores Lower ranking artificial wetlands (rank= 2, 3 or 4); lowest ranking natural or semi-natural wetlands (rank = 4). Waste water treatment works, where these do not rank in a biodiversity category. Wetlands that are outside the City boundary and so were not included in the prioritisation process.
EXP_CBA	Expert reviewed biodiversity status	Updated biodiversity category for each wetland, based on expert review	As above	
EXP_REVIEW	Expert reviewer	Organisation responsible for the expert review		

### 3 RESULTS OF PRIORITISATION

Using the City-wide ranking approach where 32 (maximum total score obtainable) is the benchmark for ranking, there were 21 wetland types that achieved rank 1. Only 5 artificial wetlands were ranked 1, one of which is a sand fynbos depression while the other 4 are sandstone fynbos depressions. This means that all of the rank 1 sandstone fynbos depressions are artificial. Focusing only on natural and semi-natural wetlands, the best wetlands in the City, in terms of biodiversity value, are mostly within the sandstone fynbos vegetation group (Table 7 and Figure 2). These are the sandstone fynbos seeps and sandstone fynbos isolated seeps – these are mostly hillslope seeps, located at higher altitudes – and sandstone fynbos valley bottom wetlands – located mostly at high altitudes or within the TMNP. The sandstone fynbos wetlands are well protected within the City – of the 360 sandstone fynbos seeps categorised as CBA1, 318 are currently within Protected Areas. A fairly high proportion of granite fynbos seeps and isolated seeps ranked highly, but these systems – all hillslope seeps at higher altitudes – are not currently well protected – 18 of 102 granite fynbos seeps categorised as CBA1 are currently protected - with many of them located close to the borders of the Hottentots Holland Nature Reserve, above Lourensford. They do, however, lie within the Biodiversity Network. These wetlands should be the focus of conservation efforts within the City.

Although few of the estuarine wetlands were placed in the CBA1 category, a large proportion were categorised as CBA2, with the exception of river mouths. A fairly large proportion of dune strandveld wetlands were placed in the CBA2 category, indicating that these wetlands are in good condition. This is true of the dune strandveld floodplain wetlands and seeps (where the majority were CBA2), and isolated depressions. Shale band seeps were all assessed as being CBA1, and shale fynbos valley bottom wetlands were mostly either CBA1 or CBA2.

Most of the City's wetlands fall within the CBA2 and OESA categories, indicating that most natural and semi-natural wetlands are in good or very poor condition, with fewer being in very good or moderate condition.

**Table 7 Biodiversity Categories assigned to the natural and semi-natural wetlands, where ranking was performed across the City. Note that not all of the 54 wetland types include natural and semi-natural wetlands. CBA = Critical Biodiversity Area; CESA = Critical Ecological Support Area; OESA = Other Ecological Support Area.**

Wetland type	CBA1	CBA2	CESA	OESA	Number of natural wetlands
alluvium fynbos floodplain			4	2	6
alluvium fynbos isolated depression			2	2	4
alluvium fynbos isolated seep	1		5	11	17
alluvium fynbos seep		8	2	30	40
alluvium fynbos valley bottom		2	4	1	7
alluvium renosterveld valley bottom				1	1
cape estuarine channel	1	9	1		11
cape estuarine depression	3	12	3		18
cape river mouth		3	6		9
dune strandveld depression		7	8	3	18
dune strandveld floodplain	1	94	54	12	161
dune strandveld isolated depression	2	248	243	153	646
dune strandveld isolated seep		39	37	57	133
dune strandveld seep		24		2	26
dune strandveld valley bottom	2	12	7	5	26
granite fynbos depression			1	1	2
granite fynbos floodplain		3	21	5	29

Wetland type	CBA1	CBA2	CESA	OESA	Number of natural wetlands
granite fynbos isolated depression		2		7	9
granite fynbos isolated seep	1	46	2	28	77
granite fynbos seep	102	65	15	13	195
granite fynbos valley bottom	11	13	32	18	74
granite renosterveld depression			1		1
granite renosterveld floodplain			1		1
granite renosterveld isolated depression			1	1	2
granite renosterveld isolated seep			2	5	7
granite renosterveld seep		2	14	9	25
granite renosterveld valley bottom		4	5	9	18
Outside CoCT				137	137
sand fynbos depression	1	22	9	12	44
sand fynbos floodplain	2	20	46	43	111
sand fynbos isolated depression	10	110	72	254	446
sand fynbos isolated seep	3	95	96	136	330
sand fynbos seep	1	25	24	61	111
sand fynbos valley bottom	5	14	27	37	83
sandstone fynbos isolated depression	5	32		1	38
sandstone fynbos isolated seep	125	287	4		416
sandstone fynbos seep	360	57	6	1	424
sandstone fynbos valley bottom	95	7	1	1	104
shale band seep	5				5
shale fynbos valley bottom	4	4	1	2	11
shale renosterveld depression			8	7	15
shale renosterveld floodplain			7	25	32
shale renosterveld isolated depression		2	2	22	26
shale renosterveld isolated seep		2	10	74	86
shale renosterveld seep			20	95	115
shale renosterveld valley bottom			15	54	69
silcrete renosterveld isolated seep			1	2	3
silcrete renosterveld seep		1		2	3
silcrete renosterveld valley bottom				2	2
<b>Total</b>	<b>740</b>	<b>1271</b>	<b>820</b>	<b>1343</b>	<b>4174</b>

Ranking wetlands within each wetland type leads to the categorisation of more wetlands to the CBA1 and CESA Biodiversity Categories, and fewer to the CBA2 and OESA categories (Table 8 and Figure 3). This approach leads to a lowering of the total score against which the ranking bands are set, and so will lead to a higher number of CBA1 wetlands in comparison to the City-wide ranking approach. This does not mean that the CBA1 wetlands are necessarily in very good condition, but these wetlands can be considered the best of each type.

Although the categorisation of wetlands was different, the overall result was similar. Wetland types, where the majority of wetlands were categorised as either CBA1 or CBA2, were the estuarine wetlands, dune strandveld wetlands (with the exception of isolated seeps), granite fynbos isolated seeps and seeps, granite renosterveld seeps, all sandstone fynbos wetland types, shale band seeps, shale fynbos valley bottom wetlands, shale renosterveld depressions and floodplains, and silcrete renosterveld seeps and isolated seeps (although the numbers were very low). Thus, those wetland types that performed well in the ranking within wetland types, but not in the City-wide ranking, are those which are the best of that type but that are not necessarily in good condition. It is probably these wetlands types that should be the focus of

conservation efforts, so that the best of each wetland type is at least protected and, preferably, rehabilitated. These include:

- Cape river mouths;
- Dune strandveld depressions and valley bottom wetlands
- Granite renosterveld seeps;
- Sandstone fynbos isolated depressions;
- Shale renosterveld depressions and floodplains, and
- Silcrete renosterveld seeps and isolated seeps.

**Table 8 Biodiversity Categories assigned to the natural and semi-natural wetlands, where ranking was performed within each wetland type. Note that not all of the 54 wetland types include natural and semi-natural wetlands. CBA = Critical Biodiversity Area; CESA = Critical Ecological Support Area; OESA = Other Ecological Support Area.**

Wetland type	CBA1	CBA2	CESA	OESA	Number of natural wetlands
alluvium fynbos floodplain	4		2		6
alluvium fynbos isolated depression		2	2		4
alluvium fynbos isolated seep	1		16		17
alluvium fynbos seep	7	1	32		40
alluvium fynbos valley bottom	3	1	3		7
alluvium renosterveld valley bottom	1				1
cape estuarine channel	9	2			11
cape estuarine depression	14	4			18
cape river mouth	5	4			9
dune strandveld depression	6	5	7		18
dune strandveld floodplain	26	102	32	1	161
dune strandveld isolated depression	127	271	197	51	646
dune strandveld isolated seep	25	23	72	13	133
dune strandveld seep	23	1	1	1	26
dune strandveld valley bottom	12	3	9	2	26
granite fynbos depression			2		2
granite fynbos floodplain	4	11	13	1	29
granite fynbos isolated depression	2		2	5	9
granite fynbos isolated seep	43	4	23	7	77
granite fynbos seep	119	49	26	1	195
granite fynbos valley bottom	21	3	49	1	74
granite renosterveld depression		1			1
granite renosterveld floodplain	1				1
granite renosterveld isolated depression	1		1		2
granite renosterveld isolated seep	2	1	4		7
granite renosterveld seep	5	11	9		25
granite renosterveld valley bottom	5	4	9		18
Outside COCT					137
sand fynbos depression	13	11	12	8	44
sand fynbos floodplain	32	11	57	11	111
sand fynbos isolated depression	35	131	135	145	446
sand fynbos isolated seep	36	79	168	47	330
sand fynbos seep	9	37	48	17	111
sand fynbos valley bottom	7	12	31	33	83
sandstone fynbos isolated depression	35	2	1		38

<b>Wetland type</b>	<b>CBA1</b>	<b>CBA2</b>	<b>CESA</b>	<b>OESA</b>	<b>Number of natural wetlands</b>
sandstone fynbos isolated seep	377	36	3		<b>416</b>
sandstone fynbos seep	371	46	6	1	<b>424</b>
sandstone fynbos valley bottom	94	7	2	1	<b>104</b>
shale band seep	5				<b>5</b>
shale fynbos valley bottom	4	4	1	2	<b>11</b>
shale renosterveld depression		9	6		<b>15</b>
shale renosterveld floodplain	1	22	9		<b>32</b>
shale renosterveld isolated depression	3	1	22		<b>26</b>
shale renosterveld isolated seep	2	10	74		<b>86</b>
shale renosterveld seep	9	21	85		<b>115</b>
shale renosterveld valley bottom	5	14	50		<b>69</b>
silcrete renosterveld isolated seep	1	1	1		<b>3</b>
silcrete renosterveld seep	1		2		<b>3</b>
silcrete renosterveld valley bottom	2				<b>2</b>
<b>Total</b>	<b>1508</b>	<b>957</b>	<b>1224</b>	<b>348</b>	<b>4174</b>

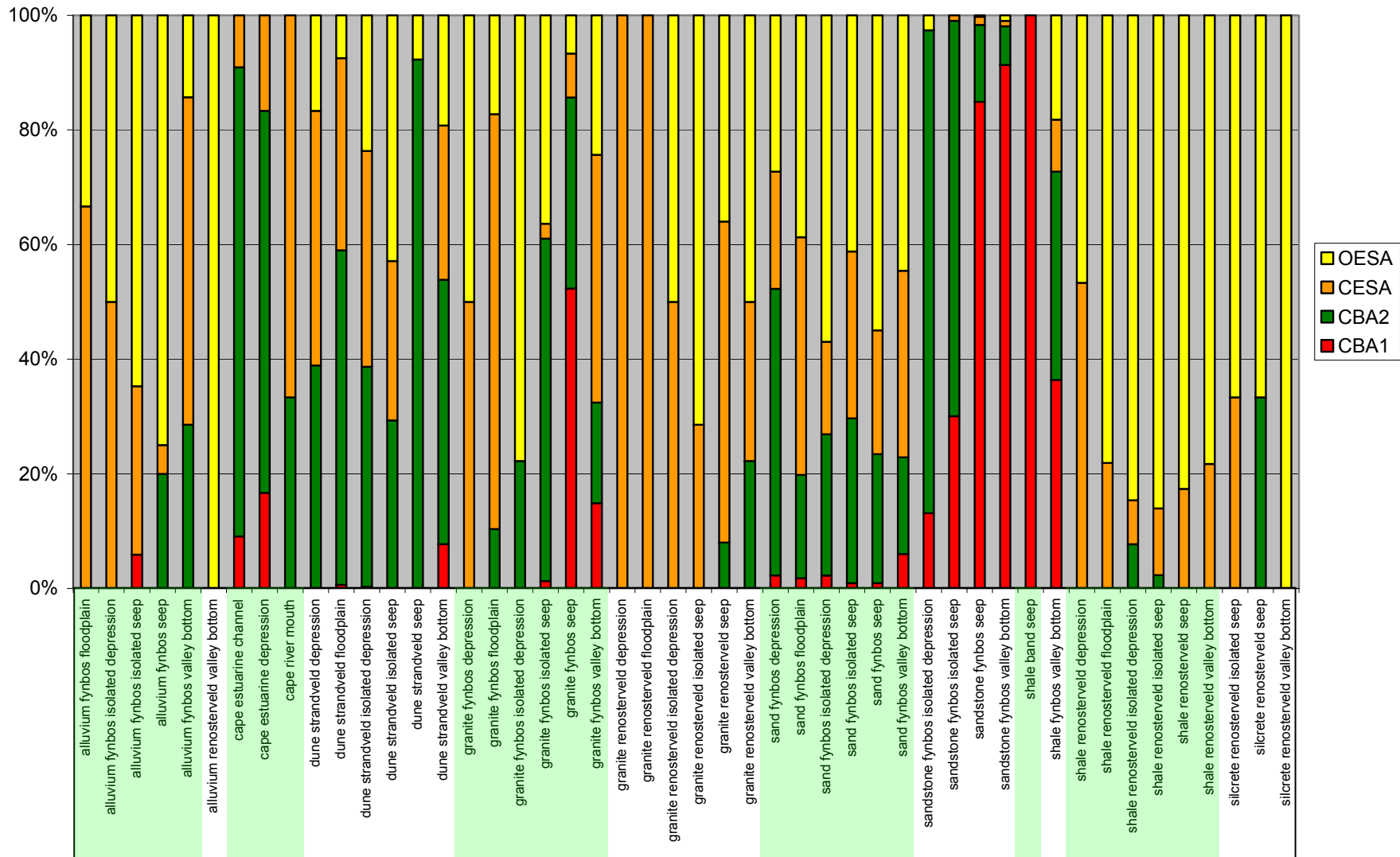


Figure 2 Bar graph of Biodiversity Categories assigned to all natural and semi-natural wetlands within the City boundary, where wetland ranking was performed across the City. CBA = Critical Biodiversity Area; CESA = Critical Ecological Support Area; OESA = Other Ecological Support Area.

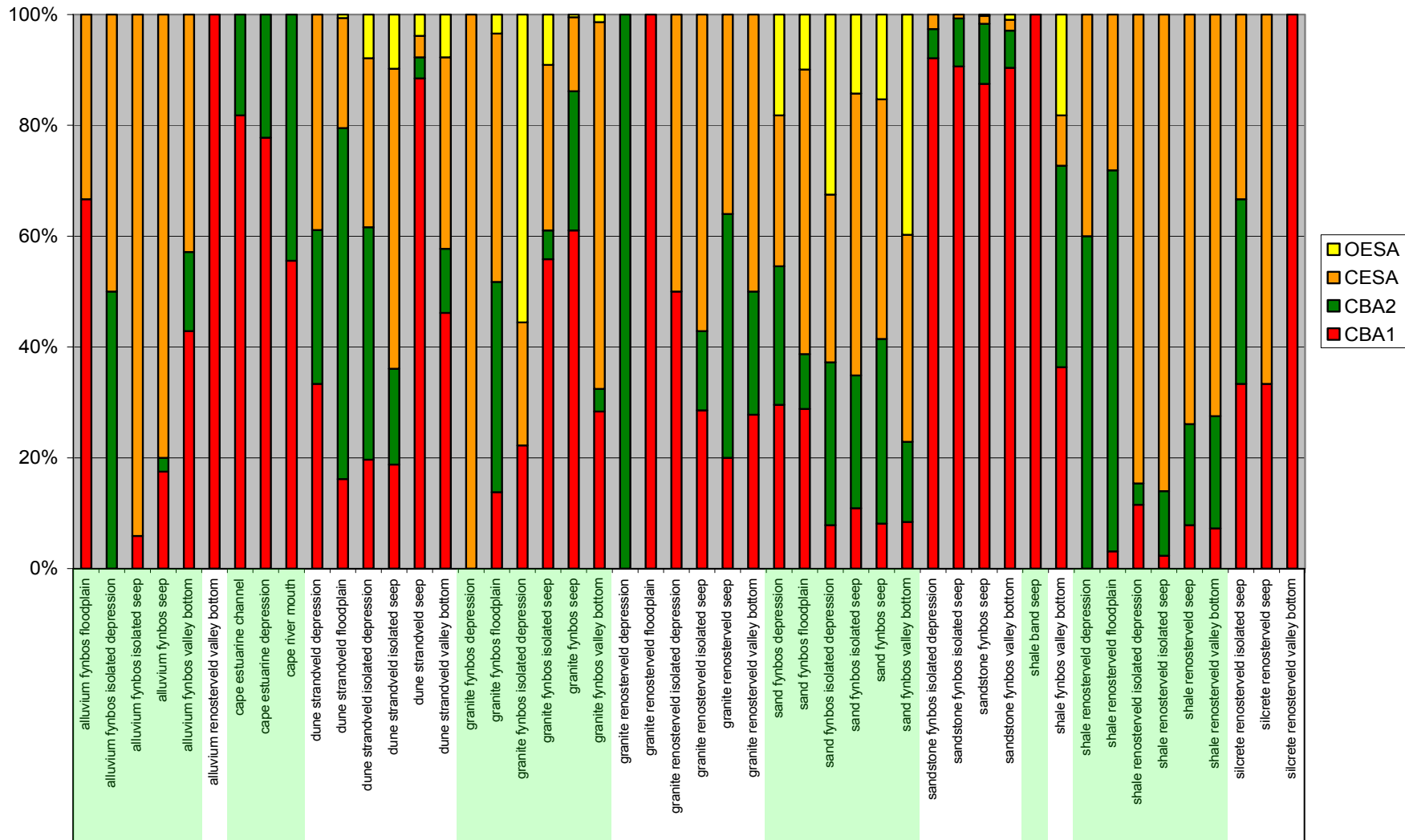


Figure 3 Bar graph of Biodiversity Categories assigned to all natural and semi-natural wetlands within the City boundary, where wetland ranking was performed within each wetland type. CBA = Critical Biodiversity Area; CESA = Critical Ecological Support Area; OESA = Other Ecological Support Area.

### 3.1 Prioritisation results for catchments

Table 9 provides summary results of the prioritisation of all wetlands (natural and artificial), for each of the 20 major natural catchments in the City, where ranking was performed within each wetland type. Of the catchments that lie entirely within the City boundary, the Noordhoek and Zeekoe catchments have the greatest wetland area as a proportion of the total catchment - 10 and 16% respectively, including artificial wetlands. However, both of these catchments have a very high percentage of artificial wetlands – 42 and 31% respectively. The Chapman's Peak (Figure 5), Llandudno (Figure 10), Muizenberg (Figure 13) and West Coast (Figure 22) catchments all have fewer than 30 wetlands, but all of these are natural and of high conservation priority as they tend to be in very good condition, as does the terrestrial vegetation in these catchments.

Other catchments that contain high (> 75%) percentages of natural and high priority wetlands include Atlantis (77% natural, mostly CBA2; Figure 4), Hout Bay (81% natural, mostly CBA; Figure 9), Silvermine (84% natural, almost all CBA; Figure 17), South Peninsula (90% natural, mostly CBA; Figure 20), and Steenbras River (98% natural, almost all CBA wetlands; Figure 21). These last three catchments include mountainous areas where wetlands tend to be protected from anthropogenic activities, and so are in relatively good condition. Many of these wetlands are already in Protected Areas.

Catchments that have wetlands that ranked low (i.e. ranked in the lower quarter of scores, and so were categorised as OESA) in terms of prioritisation include Diep River (Figure 7), Mitchells Plain / Khayelitsha (Figure 12), Noordhoek (Figure 14), Salt River (Figure 15), Sir Lowry's Pass River (Figure 18) and the Zeekoe catchment (Figure 23). The City (Figure 6), Eerste / Kuils river (Figure 8), Lourens River (Figure 8) and Sand River (Figure 16) catchments include wetlands that are fairly equally split between CBA and non-CBA (i.e. CESA and OESA) status, of which approximately two thirds are natural.

**Table 9 Summary information for each of the major natural catchments in the City, including the total number and area of wetlands, the number of natural wetlands in each catchment, and the numbers of CBA, CESA and OESA wetlands. Note that the number of CBA, CESA and OESA wetlands may not equal the total number of wetlands in the catchment, as some wetlands are reservoirs or WWTW ponds, which were not assigned to a biodiversity category.**

Catchment	Catchment area (ha)	Number of wetlands	Area of wetlands (ha)	Number of natural wetlands (% of total number of wetlands)	Number of CBA wetlands	Number of CESA wetlands	Number of OESA wetlands
Atlantis	35 651	149	226	115 (77%)	101	16	27
Chapman's Peak	653	25	12	25 (100%)	25	0	0
City	5 296	69	29	44 (64%)	38	9	16
Diep River	153 791	1493	2518	507 (33%)*	171	259	953
Eerste/Kuils River	66 680	1183	2383	802 (68%)	413	299	412
Hout Bay	3 787	181	155	146 (81%)	125	24	32
Llandudno	1 086	13	9	13 (100%)	12	1	0
Lourens River	12 455	394	736	248 (63%)	180	84	114
Mitchells Plain / Khayelitsha	7 552	286	236	95 (33%)	47	81	138
Muizenberg	556	5	2	5 (100%)	5	0	0
Noordhoek	3 516	146	352	62 (42%)	41	16	76
Salt River	25 034	798	655	342 (43%)	132	90	444
Sand River	9 655	338	478	226 (67%)	107	103	123
Silvermine	2 156	100	99	84 (84%)	84	3	13
Sir Lowry's Pass	7 576	336	287	158 (47%)	79	89	155
Sout River	14 192	343	241	179 (52%)	77	119	125
South Peninsula	16 798	619	773	557 (90%)	546	20	32
Steenbras River	7 184	194	996	191 (98%)	184	8	2
West Coast	1 707	17	7	3 (18%)	2	1	14
Zeekoe	7 812	652	1277	204 (31%)	65	218	369

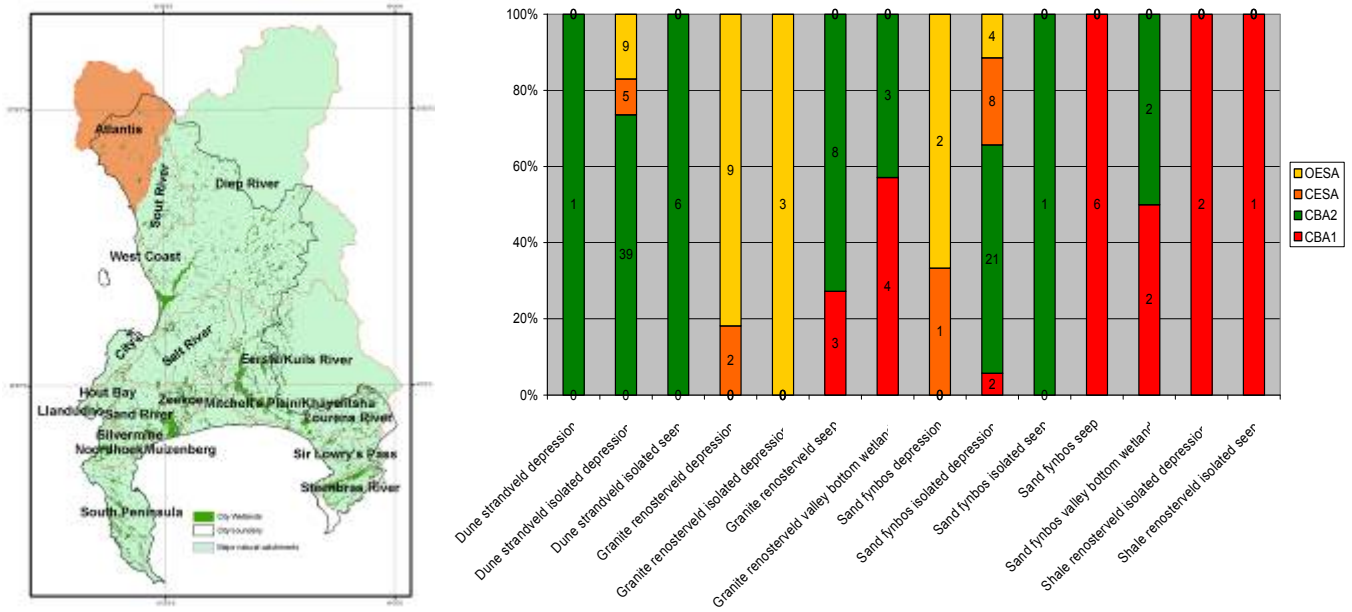


Figure 4 Bar graph of the wetland types in the Atlantis catchment, including both natural and artificial wetlands. Bars are split according to the Biodiversity Category status of the wetlands.

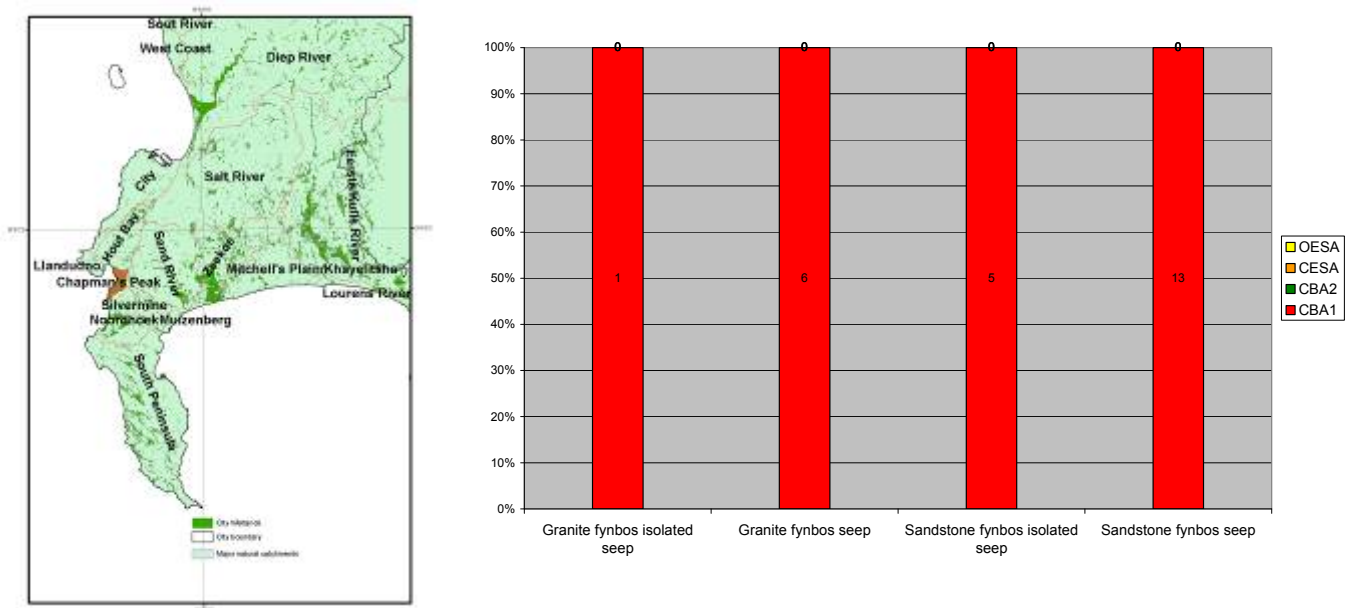


Figure 5 Bar graph of the wetland types in the Chapmans Peak catchment, which contains only natural wetlands, all of which were accorded CBA1 status.

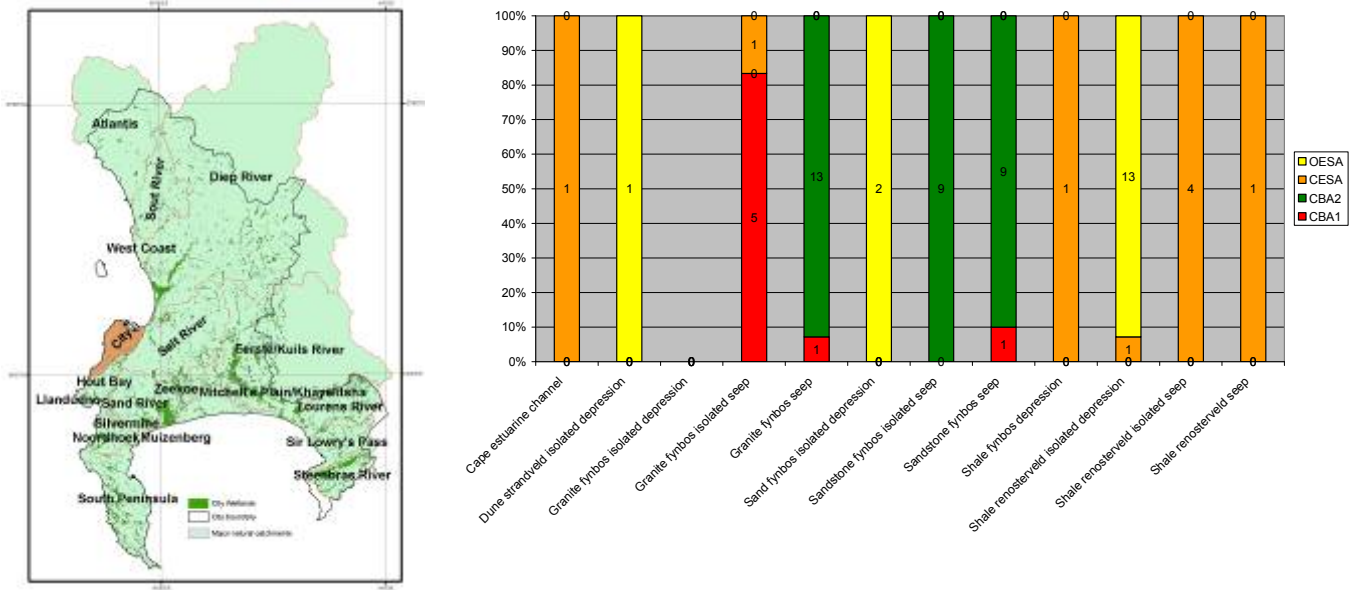


Figure 6 Bar graph of the wetland types in the City bowl, including both natural and artificial wetlands. Bars are split according to the Biodiversity Category status of the wetlands.

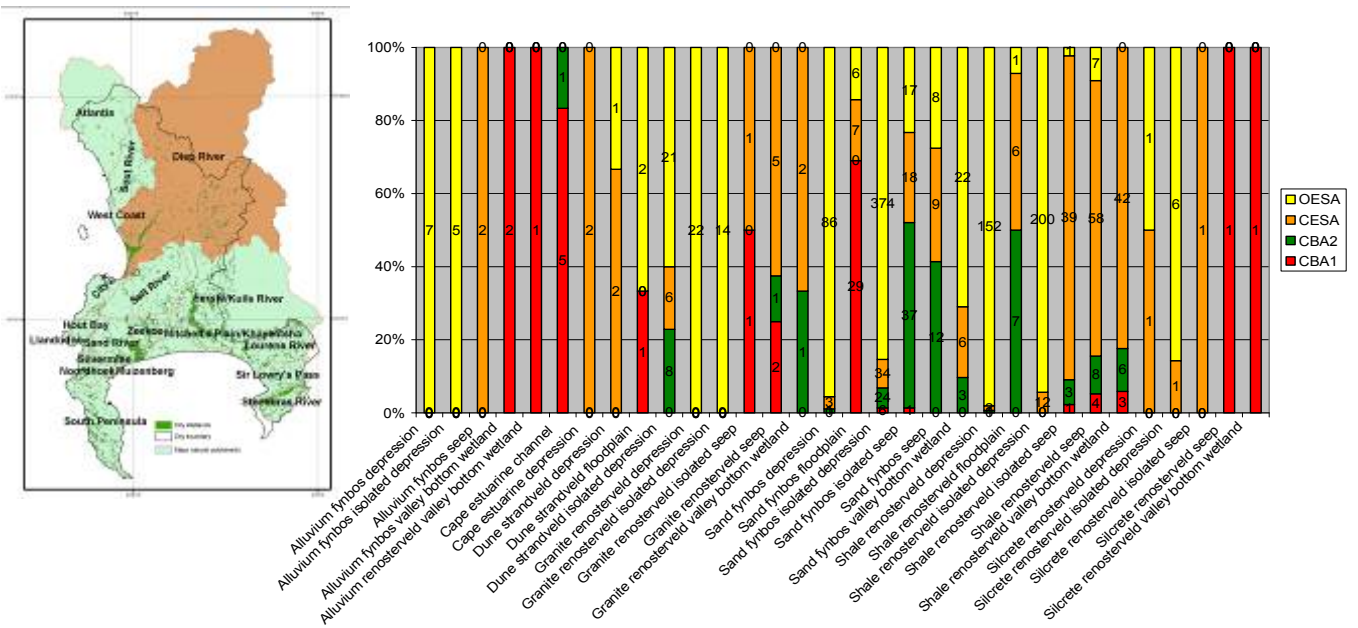


Figure 7 Bar graph of the wetland types in the Diep River catchment, including both natural and artificial wetlands. Bars are split according to the Biodiversity Category status of the wetlands.

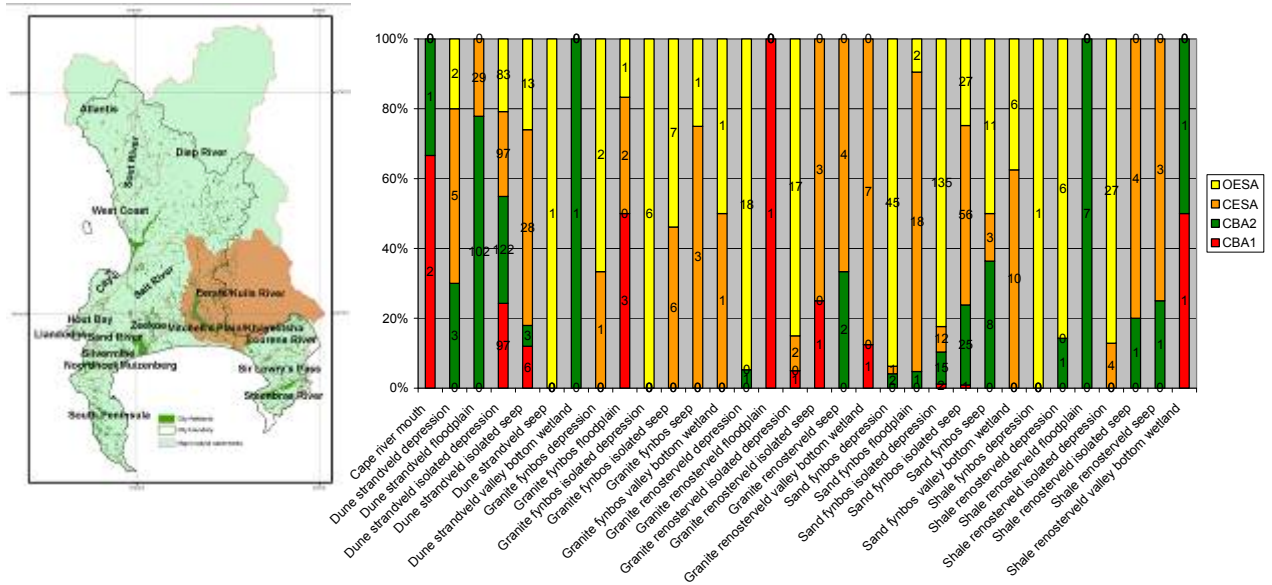


Figure 8 Bar graph of the wetland types in the Eerste/Kuils river catchments, including both natural and artificial wetlands. Bars are split according to the Biodiversity Category status of the wetlands.

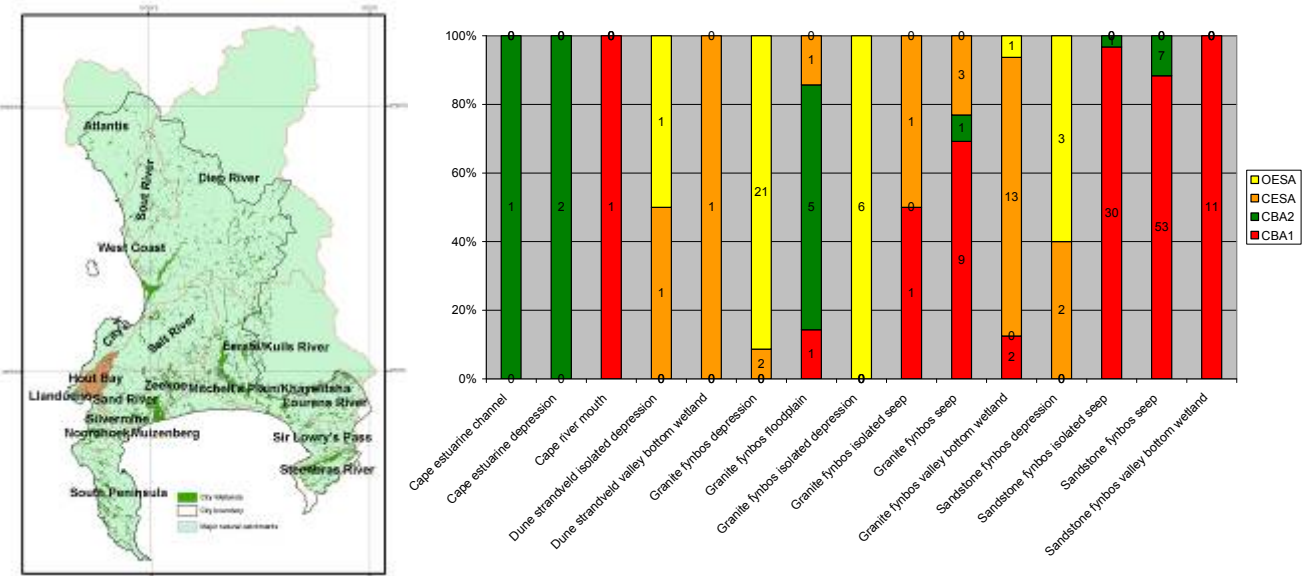
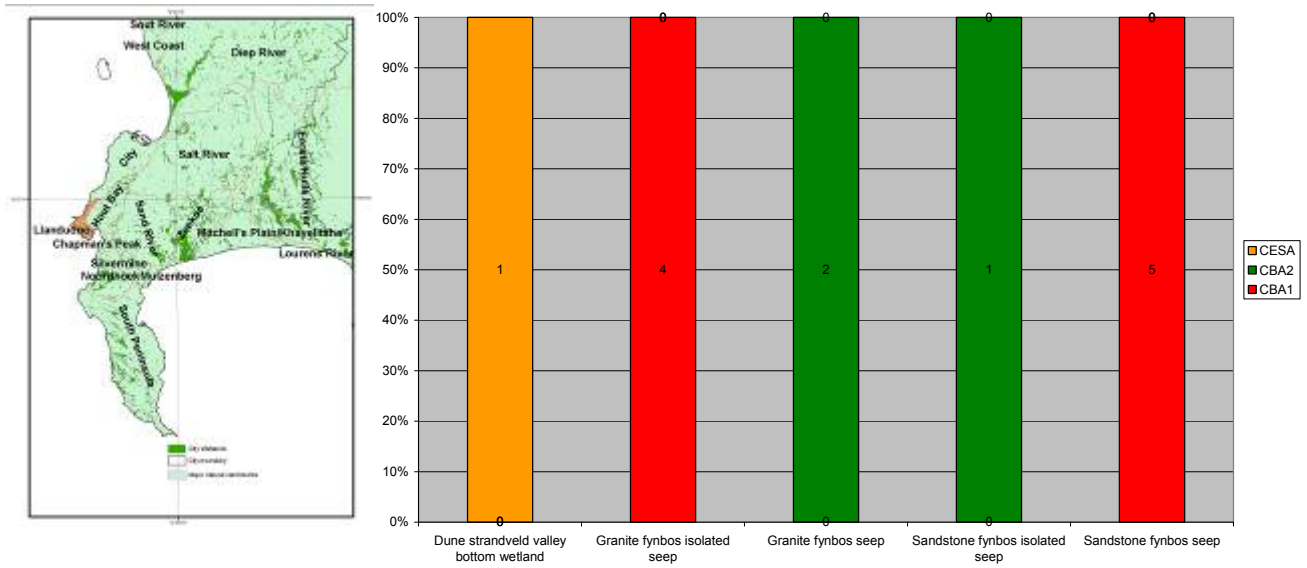
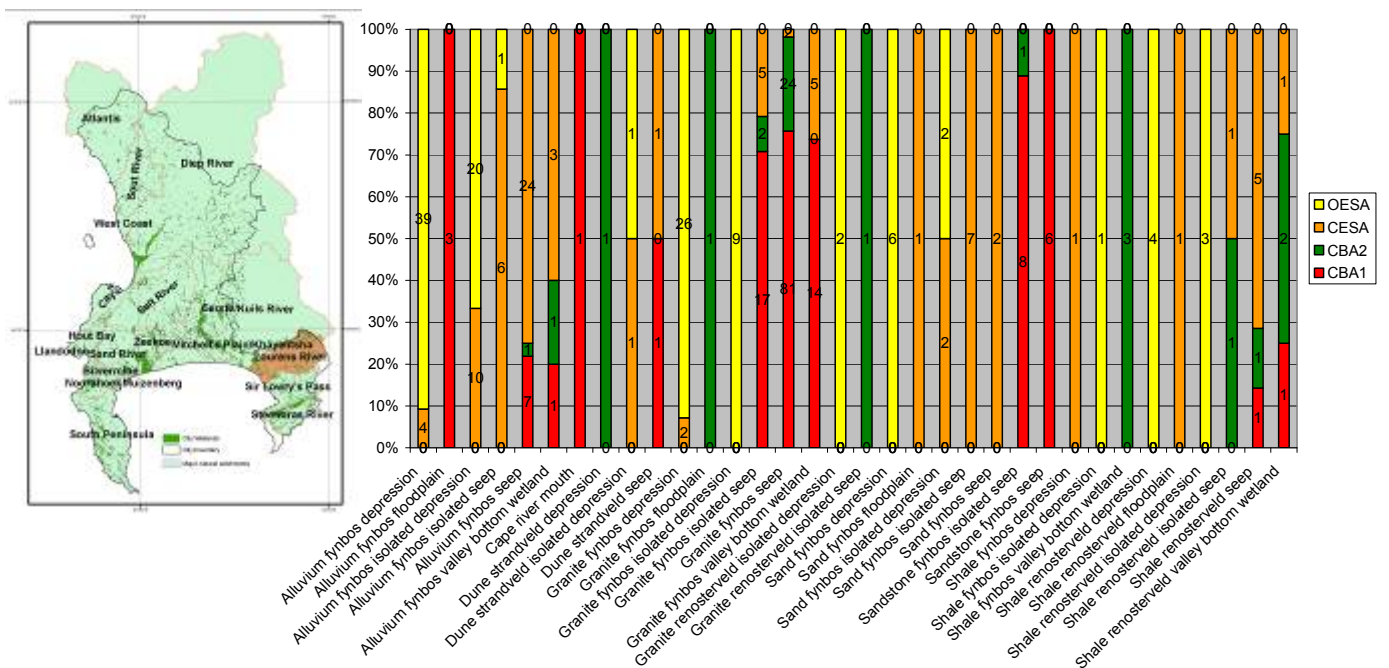


Figure 9 Bar graph of the wetland types in the Hout Bay catchment, including both natural and artificial wetlands. Bars are split according to the Biodiversity Category status of the wetlands.



**Figure 10** Bar graph of the wetland types in the Llandudno catchment, including both natural and artificial wetlands. Bars are split according to the Biodiversity Category status of the wetlands, none of which was categorised as an OESA.



**Figure 11** Bar graph of the wetland types in the Lourens River catchment, including both natural and artificial wetlands. Bars are split according to the Biodiversity Category status of the wetlands.

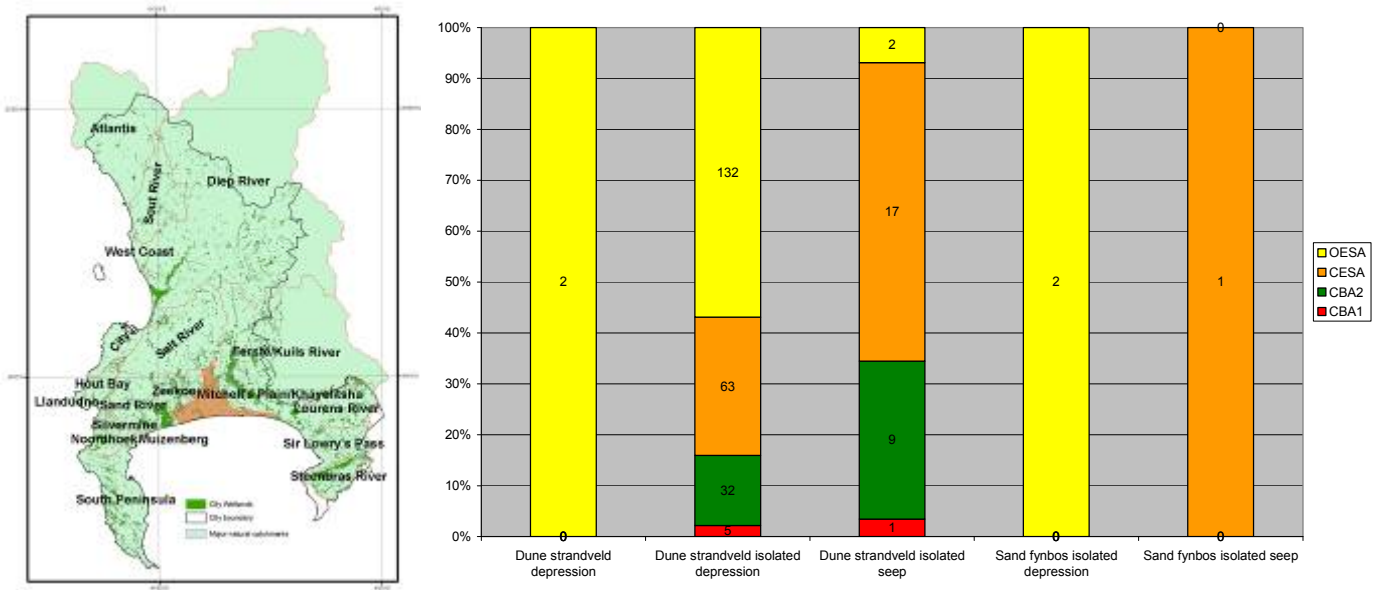


Figure 12 Bar graph of the wetland types in the Mitchell's Plain/Khayelitsha catchments, including both natural and artificial wetlands. Bars are split according to the Biodiversity Category status of the wetlands.

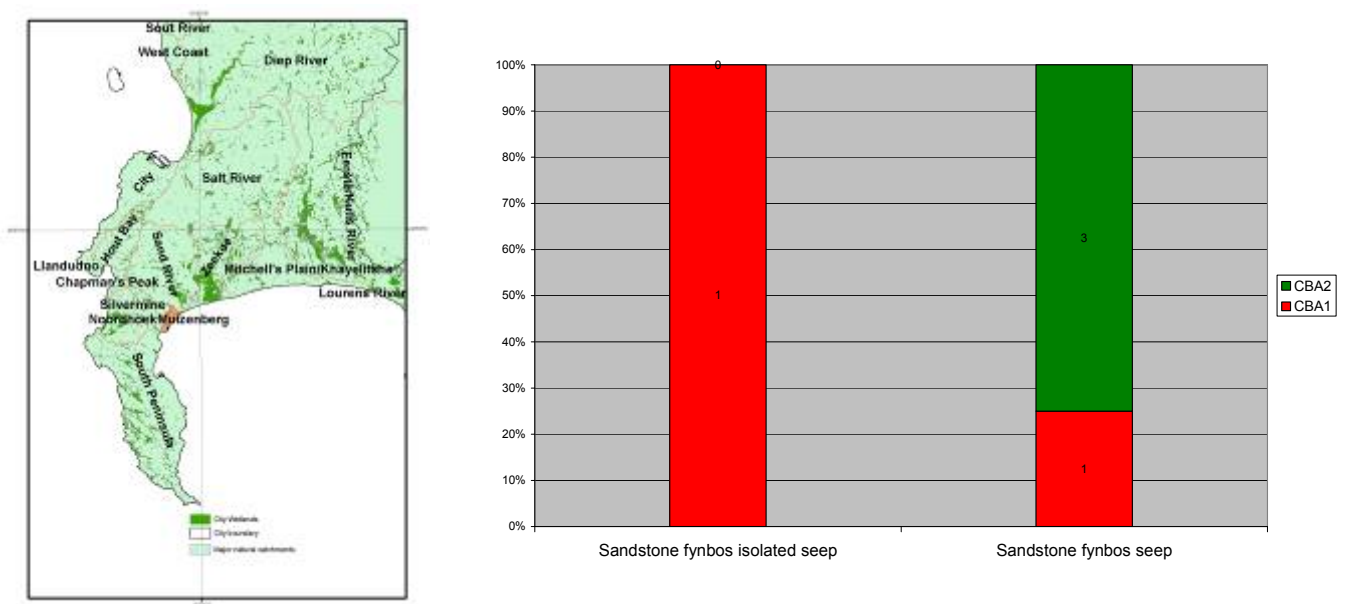


Figure 13 Bar graph of the wetland types in the Muizenberg catchment, all of which are natural. Bars are split according to the Biodiversity Category status of the wetlands.

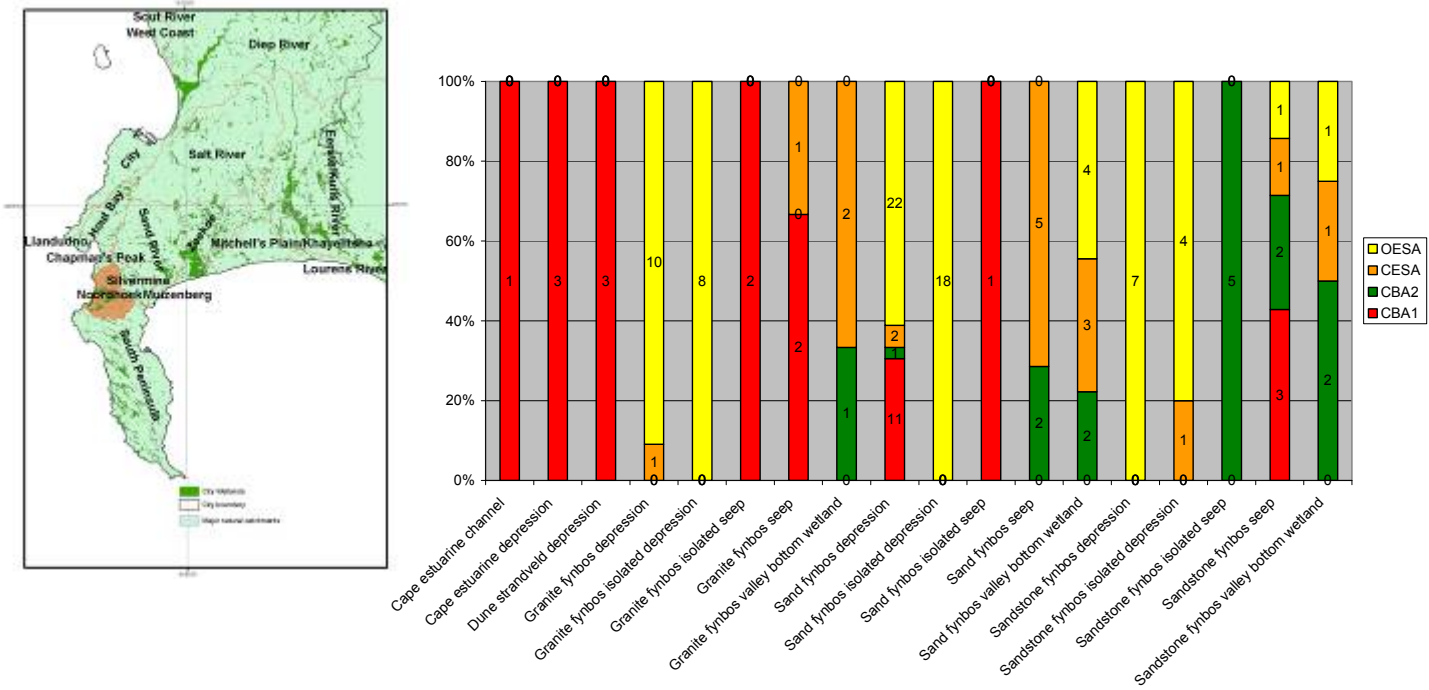


Figure 14 Bar graph of the wetland types in the Noordhoek catchment, including both natural and artificial wetlands. Bars are split according to the Biodiversity Category status of the wetlands.

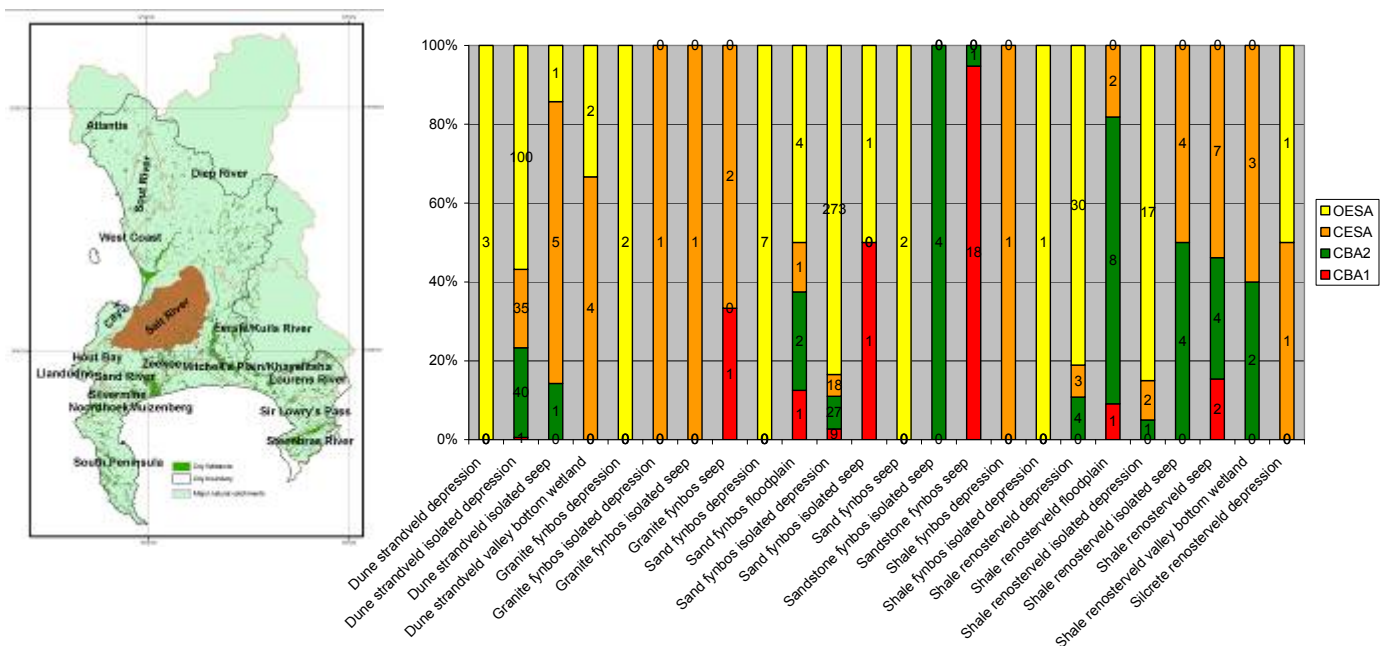


Figure 15 Bar graph of the wetland types in the Salt River catchment, including both natural and artificial wetlands. Bars are split according to the Biodiversity Category status of the wetlands.

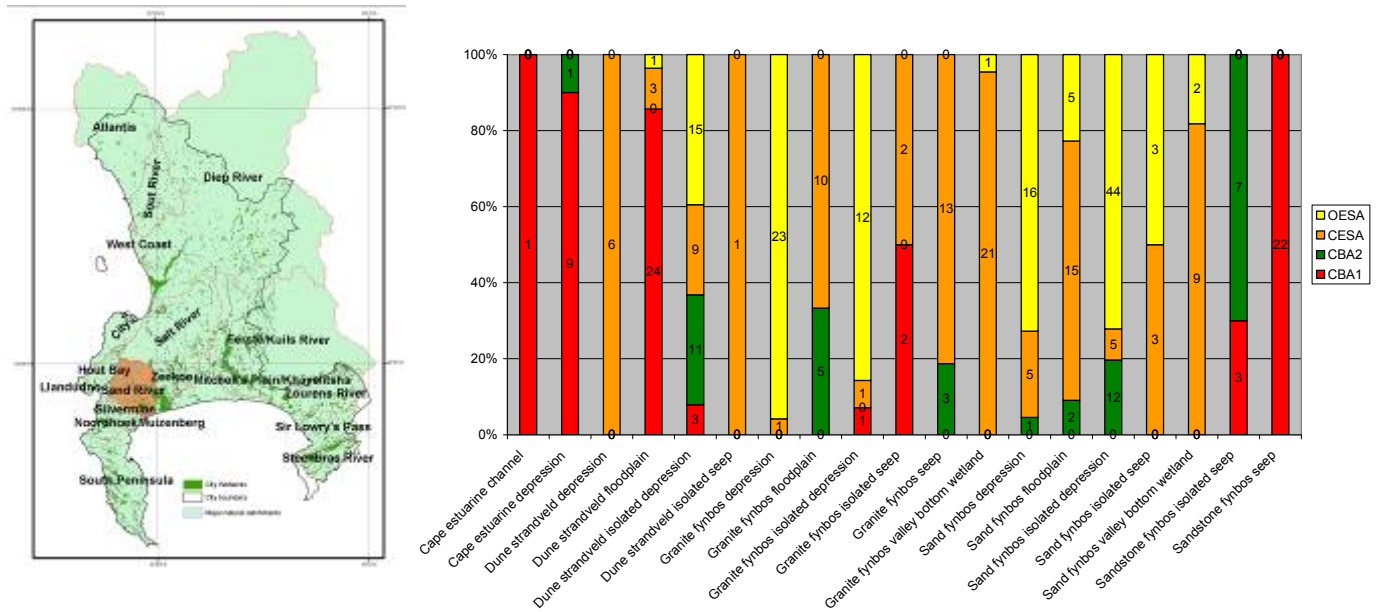


Figure 16 Bar graph of the wetland types in the Sand River catchment, including both natural and artificial wetlands. Bars are split according to the Biodiversity Category status of the wetlands.

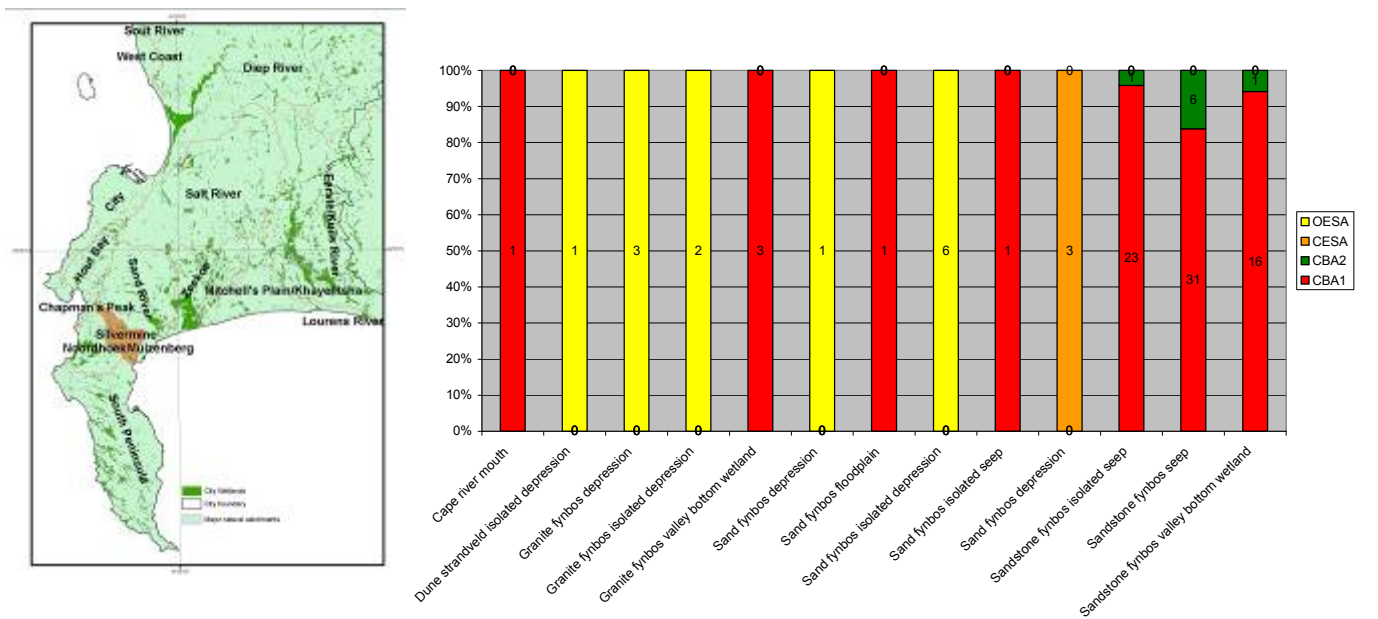


Figure 17 Bar graph of the wetland types in the Silvermine River catchment, including both natural and artificial wetlands. Bars are split according to the Biodiversity Category status of the wetlands.

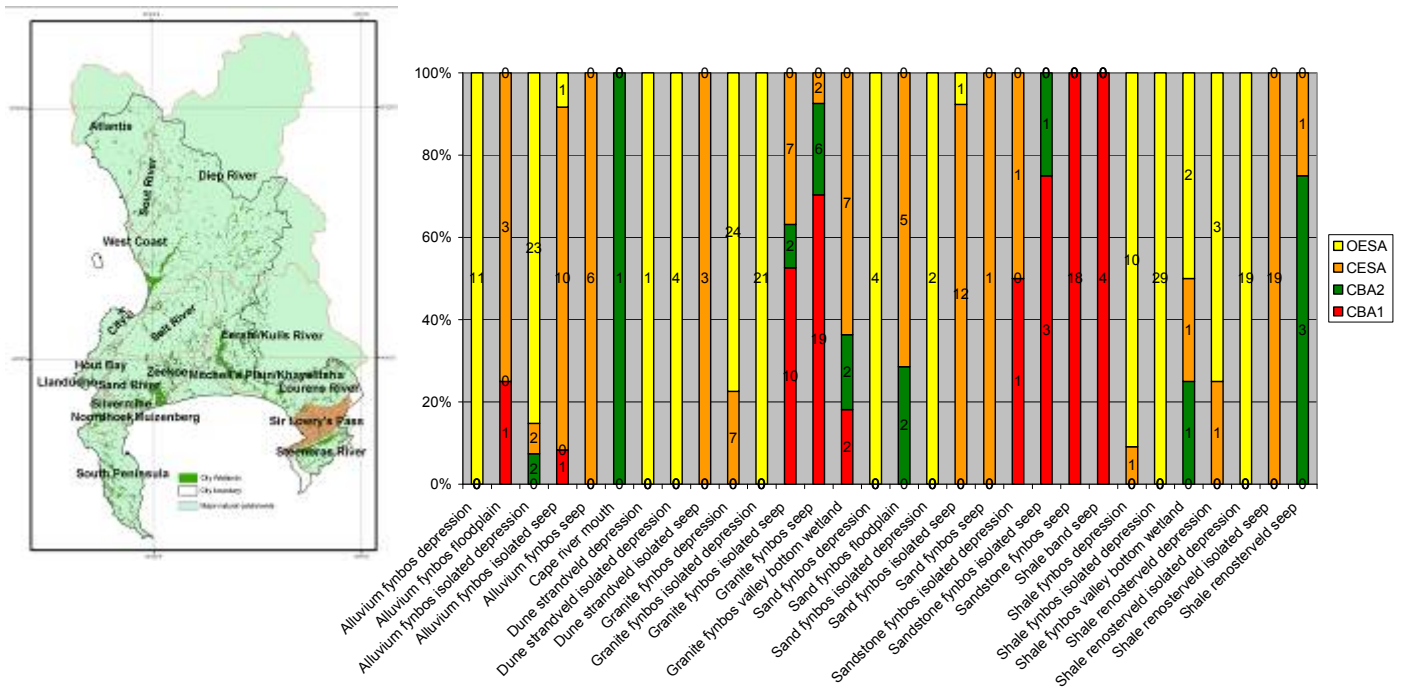


Figure 18 Bar graph of the wetland types in the Sir Lowry's Pass River catchment, including both natural and artificial wetlands. Bars are split according to the Biodiversity Category status of the wetlands.

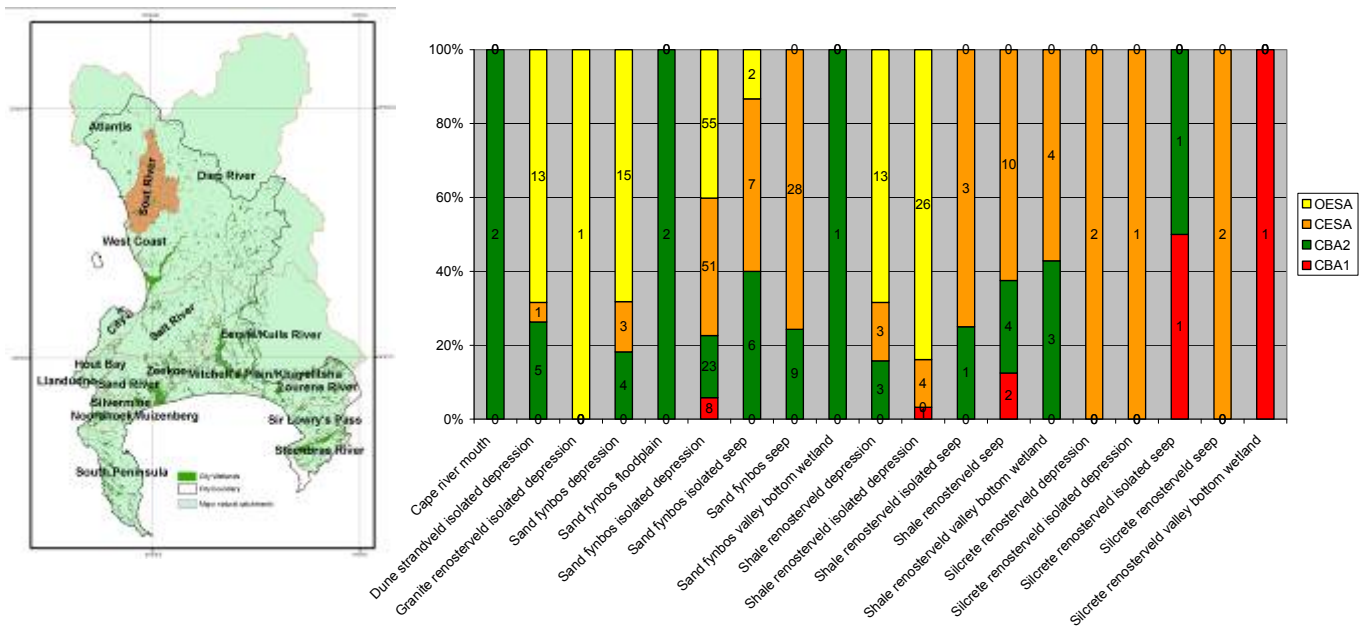


Figure 19 Bar graph of the wetland types in the Sout River catchment, including both natural and artificial wetlands. Bars are split according to the Biodiversity Category status of the wetlands.

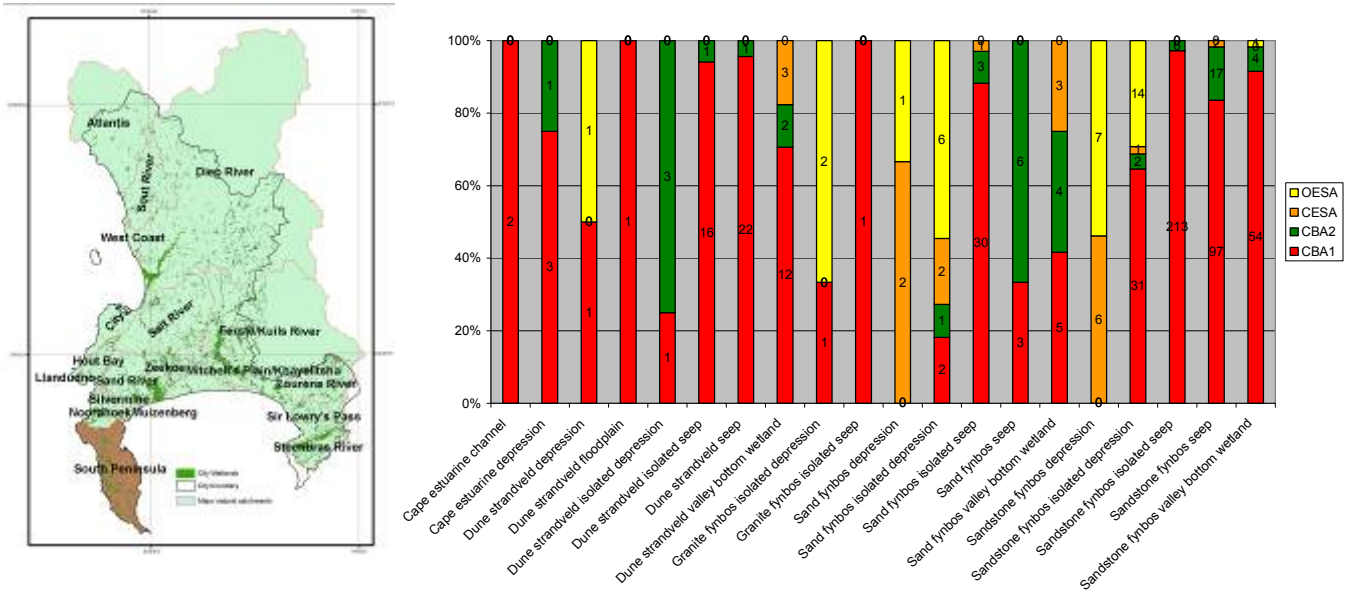


Figure 20 Bar graph of the wetland types in the South Peninsula, including both natural and artificial wetlands. Bars are split according to the Biodiversity Category status of the wetlands.

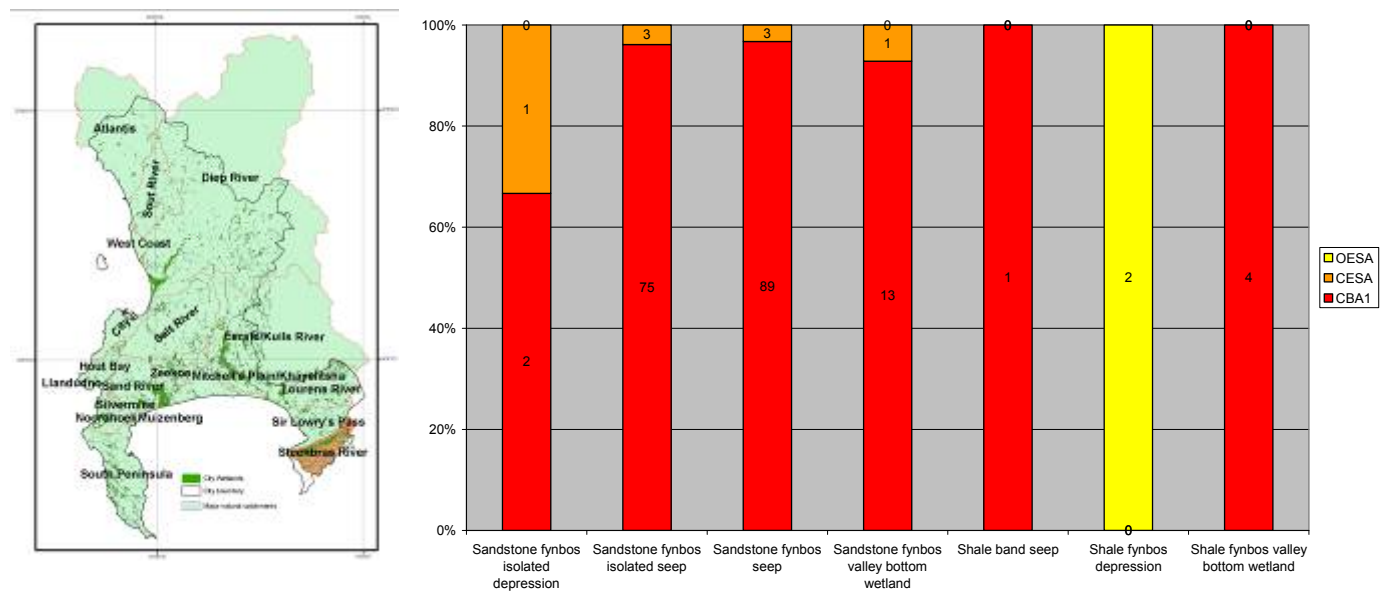


Figure 21 Bar graph of the wetland types in the Steenbras River catchment, including both natural and artificial wetlands. Bars are split according to the Biodiversity Category status of the wetlands.

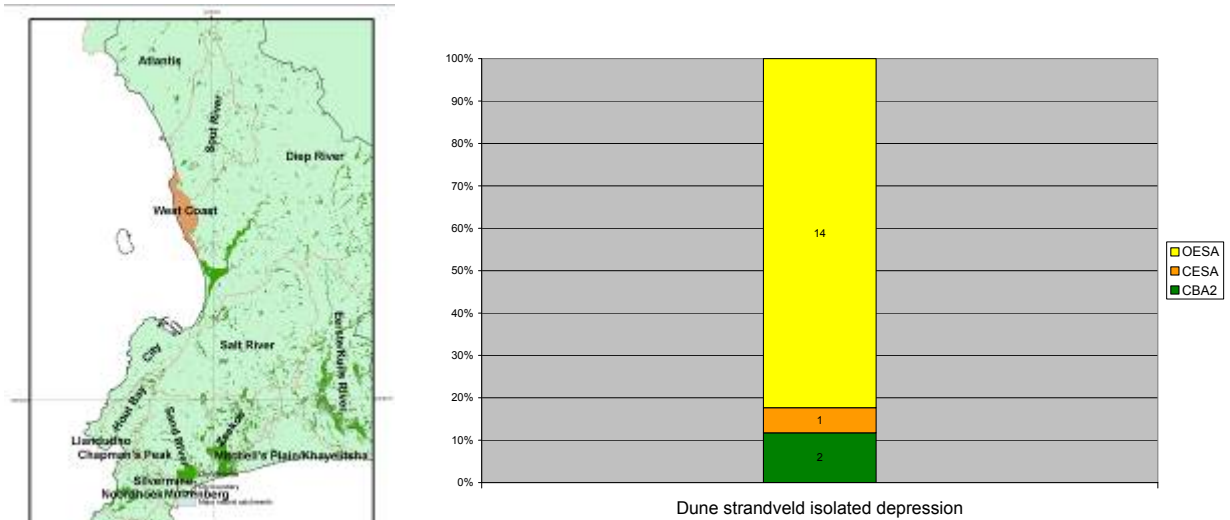


Figure 22 Bar graph of the one wetland type in the West Coast catchment. Only 3 of these wetlands are natural.

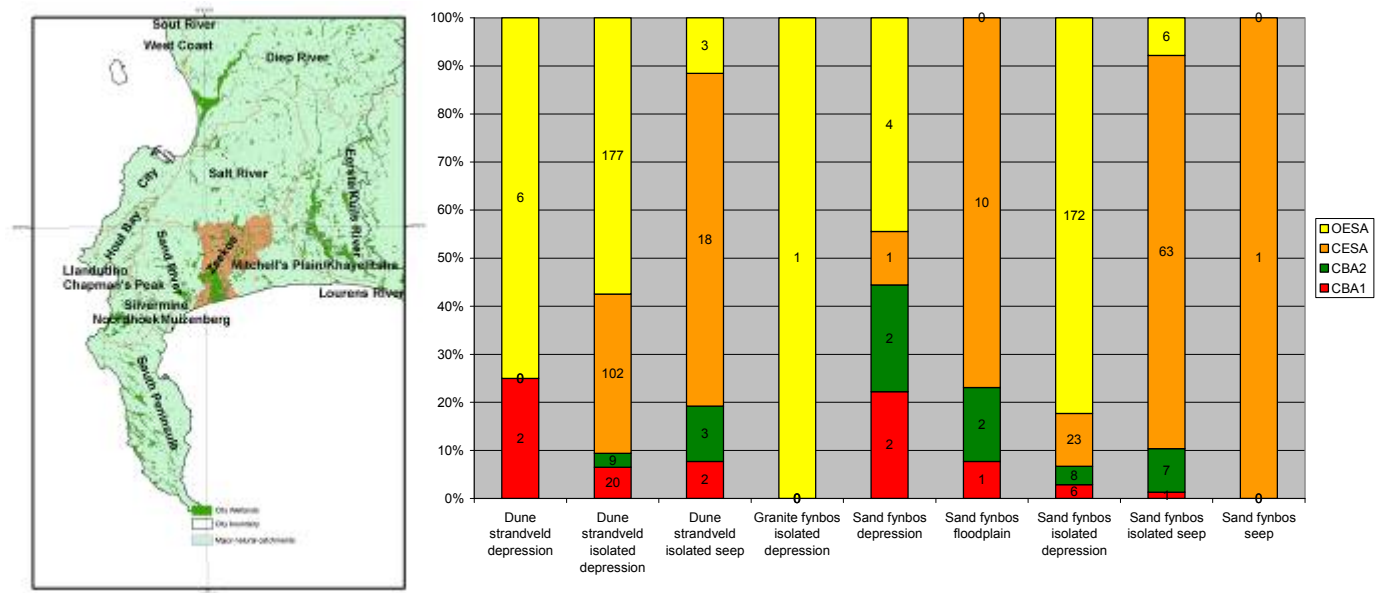
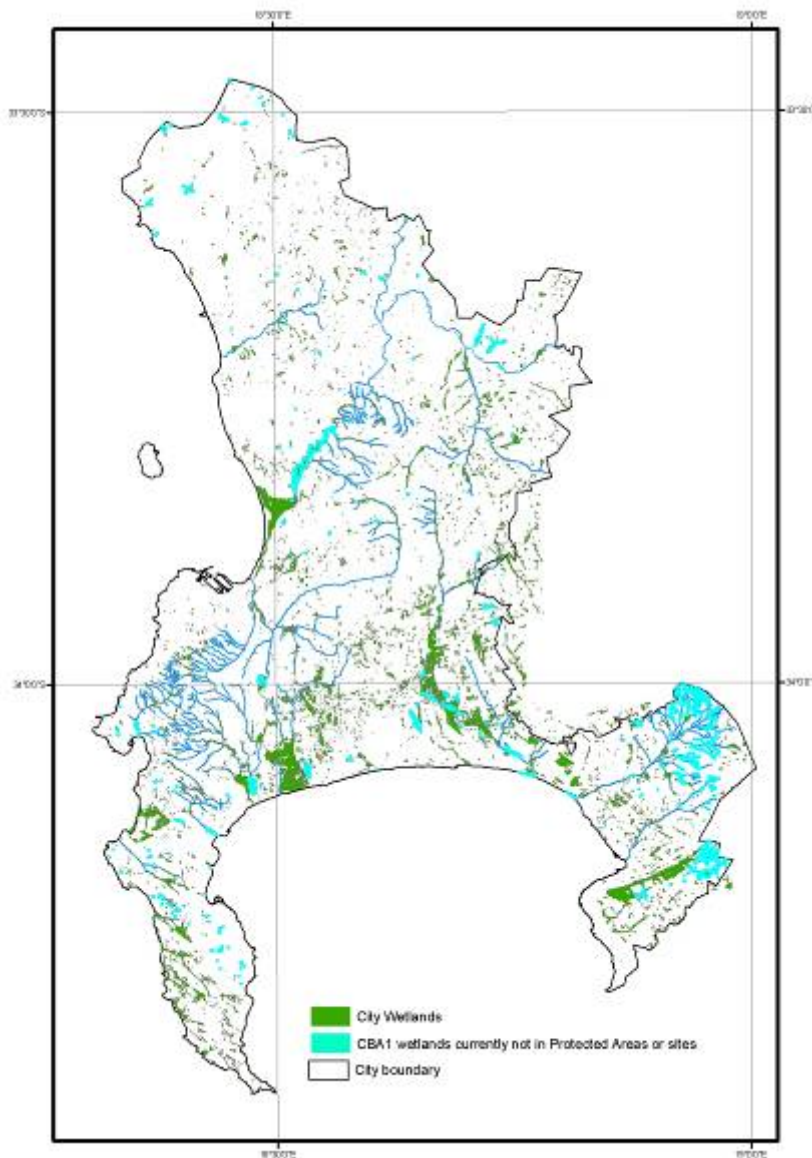


Figure 23 Bar graph of the wetland types in the Zeekoe catchment, including both natural and artificial wetlands. Bars are split according to the Biodiversity Category status of the wetlands.

### 3.2 Conclusions, target setting and integration with the Biodiversity Network

- A total of 7677 wetlands were mapped in the City of Cape Town, including 306 that are located outside of the City boundary. 4174 wetlands are considered to be natural or semi-natural, and 3503 artificial.



**Figure 24** Map of the City of Cape Town wetlands, indicating those that are categorised as CBA1, through ranking within each wetland type, which are currently not within Protected Areas or sites. CBA = Critical Biodiversity Area.

- The prioritisation of wetlands, using a *City-wide ranking* approach, resulted in the categorisation of 740 wetlands as CBA1, and 1271 wetlands as CBA2. Of these 177 (24%) of CBA1 wetlands and 638 (50%) of CBA2 wetlands are currently not within Protected Areas or sites. Ranking wetlands *within each wetland type* led to the categorisation of 1508 wetlands as CBA1 and 957 as CBA2. One artificial wetland, the wetland at Marina da Gama, was promoted to CBA1, despite its artificial status, increasing the total number of CBA1 wetlands to 1509. Of these, 451 (30%) CBA1 wetlands and 792 (83%) are not in Protected areas or sites, or currently under any conservation management (Table 10; Figure 24). It is these wetlands that should be the focus of conservation effort, and it is these areas that should be investigated for the expansion of the terrestrial Biodiversity Network, where these areas do not have any status within the Network.
- There are a number of wetland types where the high ranking natural and semi-natural wetlands (i.e. those ranked 1, and so categorised as CBA1) are mostly (> 75%) not protected (Table 10). For instance, none of the high ranking alluvium fynbos valley bottom wetlands and the alluvium renosterveld valley bottom

wetlands are currently protected. These wetlands mostly occur in the Somerset West area, associated with the Lourens and Sir Lowry's Pass rivers, where farming and urban development have had a severe impact on the wetlands, especially those on the valley floors.

- Of the estuarine wetlands, the cape river mouths are the least protected, and also in the poorest condition, with only 56% of these systems being categorised as CBA1, in comparison with the estuarine channels and depressions, of which 75 and 71% were ranked very highly. Using the City-wide ranking approach, only three of the river mouths were categorised as CBA – these are the river mouths on the Lourens River and Eerste River (made up of two polygons).
- Most of the granite fynbos and granite renosterveld CBA1 wetlands are not protected at present. This is true for the sand fynbos floodplain wetlands and seeps, while the sandstone and shale fynbos wetlands, which tend to occur in the mountains, are currently well protected. The shale renosterveld systems are mostly in poor condition, and few are protected.
- There are only 14 CBA1 wetlands that are not currently given status within the Biodiversity Network, or which are on “transformed” land (Figure 25). These include:
  - A granite renosterveld valley bottom wetland in the Atlantis catchment;
  - An alluvium renosterveld valley bottom wetland, a silcrete renosterveld valley bottom wetland, a granite renosterveld isolated seep and a piece of a sand fynbos floodplain (along the lower Diep River) in the Diep River catchment;
  - A silcrete renosterveld valley bottom wetland and a shale renosterveld seep in the Sout River catchment;
  - Granite renosterveld floodplain in the Eerste / Kuils river catchment;
  - A shale renosterveld seep, and an alluvium fynbos floodplain in the Lourens River catchment;
  - The Marina da Gama area of Zandvlei – estuarine depression – in the Sand River catchment;
  - The lower Silvermine River, i.e. cape river mouth, and
  - The lower Hout Bay River, comprising a granite fynbos floodplain (heavily impacted) and the river mouth.
- Many of these wetlands are isolated, small systems, and it may not make sense to expand the Network to include them. However, it is recommended that the Network be expanded to at least incorporate the land around the lower sections of the Diep, Silvermine and Hout Bay rivers.

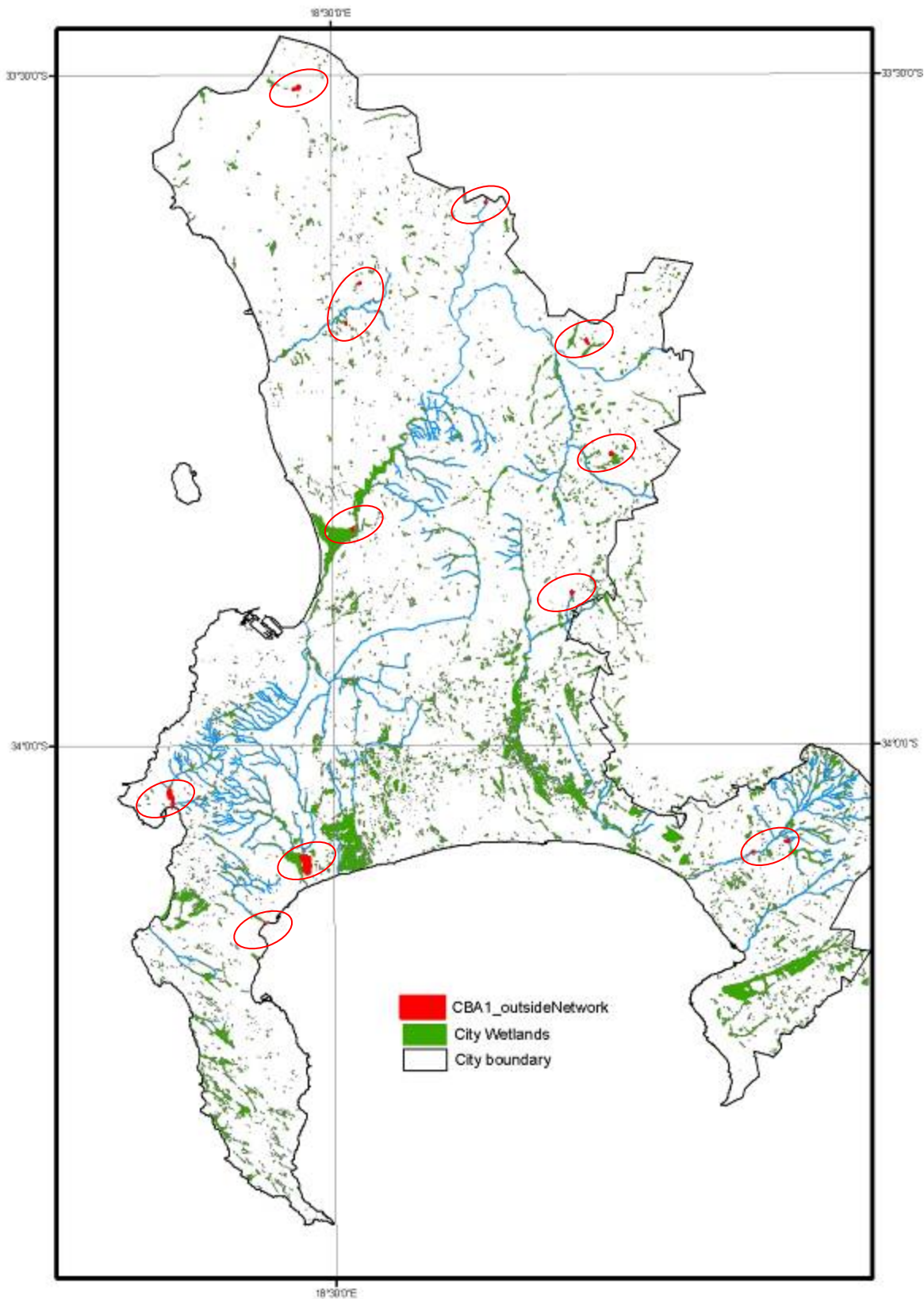


Figure 25 Map of the City of Cape Town wetlands, indicating the locations (circled) of CBA1 wetlands that are outside of the Biodiversity Network.

**Table 10** Data on biodiversity categories assigned to the 54 wetland types within the City of Cape Town, using the within wetland type ranking approach, and including natural and artificial wetlands. CBA = Critical Biodiversity Areas; CESA = Critical Ecological Support Areas; OESA = Other Ecological Support Areas.

	Wetland type	CBA1	CBA2	CESA	OESA	WWTW	Number of wetlands of each wetland type	% of wetlands categorised as CBA1	Number of CBA1 wetlands not currently Protected	% CBA1 wetlands not protected
1	Alluvium fynbos depression	0	0	4	57	0	61	0.00		
2	Alluvium fynbos floodplain	4	0	3	0	0	7	57.14	4	100.0
3	Alluvium fynbos isolated depression	0	2	12	48	13	75	0.00		
4	Alluvium fynbos isolated seep	1	0	16	2	0	19	5.26		
5	Alluvium fynbos seep	7	1	32	0	0	40	17.50	1	14.3
6	Alluvium fynbos valley bottom wetland	3	1	3	0	0	7	42.86	3	100.0
7	Alluvium renosterveld valley bottom wetland	1	0	0	0	0	1	100.00	1	100.0
8	Cape estuarine channel	9	2	1	0	0	12	75.00	1	11.1
9	Cape estuarine depression	15	4	2	0	0	21	71.43	1	6.7
10	Cape river mouth	5	4	0	0	0	9	55.56	5	100.0
11	Dune strandveld depression	6	5	13	16	0	40	15.00		
12	Dune strandveld floodplain	26	102	32	3	0	163	15.95		
13	Dune strandveld isolated depression	127	271	321	572	67	1358	9.35	76	59.8
14	Dune strandveld isolated seep	25	23	72	19	0	139	17.99	3	12.0
15	Dune strandveld seep	23	1	1	1	0	26	88.46	2	8.7
16	Dune strandveld valley bottom wetland	12	3	9	2	0	26	46.15		
17	Granite fynbos depression	0	0	14	111	0	125	0.00		
18	Granite fynbos floodplain	4	11	13	1	0	29	13.79	3	75.0
19	Granite fynbos isolated depression	2	0	2	67	4	75	2.67		
20	Granite fynbos isolated seep	43	4	23	7	0	77	55.84	31	72.1
21	Granite fynbos seep	119	49	26	1	0	195	61.03	95	79.8
22	Granite fynbos valley bottom wetland	21	3	49	3	0	76	27.63	16	76.2
23	Granite renosterveld depression	0	1	2	49	0	52	0.00		
24	Granite renosterveld floodplain	1	0	0	0	0	1	100.00	1	100.0
25	Granite renosterveld isolated depression	1	0	2	37	0	40	2.50		
26	Granite renosterveld isolated seep	2	1	4	0	0	7	28.57	2	100.0

	Wetland type	CBA1	CBA2	CESA	OESA	WWTW	Number of wetlands of each wetland type	% of wetlands categorised as CBA1	Number of CBA1 wetlands not currently Protected	% CBA1 wetlands not protected
27	Granite renosterveld seep	5	11	9	0	0	25	20.00	5	100.0
28	Granite renosterveld valley bottom wetland	5	4	9	0	0	18	27.78	5	100.0
29	Sand fynbos depression	13	11	18	209	8	259	5.02	2	15.4
30	Sand fynbos floodplain	32	11	57	17	0	117	27.35	26	81.3
31	Sand fynbos isolated depression	35	131	155	1096	142	1559	2.25	21	60.0
32	Sand fynbos isolated seep	36	79	168	57	0	340	10.59	3	8.3
33	Sand fynbos seep	9	37	49	21	0	116	7.76	7	77.8
34	Sand fynbos valley bottom wetland	7	12	31	34	0	84	8.33	2	28.6
35	Sandstone fynbos depression	0	0	11	17	0	28	0.00		
36	Sandstone fynbos isolated depression	35	2	4	18	0	59	59.32	10	28.6
37	Sandstone fynbos isolated seep	377	36	3	0	0	416	90.63	47	12.5
38	Sandstone fynbos seep	371	46	6	1	0	424	87.50	45	12.1
39	Sandstone fynbos valley bottom wetland	94	7	2	2	0	105	89.52	10	10.6
40	Shale band seep	5	0	0	0	0	5	100.00		
41	Shale fynbos depression	0	0	4	13	0	17	0.00		
42	Shale fynbos isolated depression	0	0	1	31	0	32	0.00		
43	Shale fynbos valley bottom wetland	4	4	1	2	0	11	36.36	1	25.0
44	Shale renosterveld depression	0	9	9	208	0	226	0.00		
45	Shale renosterveld floodplain	1	22	9	1	0	33	3.03	1	100.0
46	Shale renosterveld isolated depression	3	1	23	305	0	332	0.90	3	100.0
47	Shale renosterveld isolated seep	2	10	74	1	0	87	2.30	2	100.0
48	Shale renosterveld seep	9	21	85	7	0	122	7.38	7	77.8
49	Shale renosterveld valley bottom wetland	5	14	50	0	0	69	7.25	5	100.0
50	Silcrete renosterveld depression	0	0	4	2	0	6	0.00		
51	Silcrete renosterveld isolated depression	0	0	2	6	0	8	0.00		
52	Silcrete renosterveld isolated seep	1	1	1	0	0	3	33.33	1	100.0
53	Silcrete renosterveld seep	1	0	2	0	0	3	33.33	1	100.0
54	Silcrete renosterveld valley bottom wetland	2	0	0	0	0	2	100.00	2	100.0
	<b>TOTALS:</b>	<b>1509</b>	<b>957</b>	<b>1443</b>	<b>3044</b>	<b>234</b>	<b>7187</b>		<b>451</b>	

- In terms of target setting, it is recommended that the target set for Cape Lowland Freshwater Wetlands, which was used for the C.A.P.E. fine-scale biodiversity plans – 24% - be used for those wetland types that are not particularly rare within the City of Cape Town.
- The target for estuaries and rare wetland types should be 100% of all CBA wetlands.
- The target for rare wetland types should be in the order of 40%. It is recommended that the benchmark for rarity be set at fewer than 20 wetlands within the type. Thus, this would include the following wetland types (see Table 10):
  - Alluvium fynbos floodplain and valley bottom wetlands;
  - Alluvium renosterveld valley bottom wetlands;
  - Granite renosterveld floodplain, isolated seeps and valley bottom wetlands;
  - Shale band seeps;
  - Shale fynbos depressions and valley bottom wetlands, and
  - Silcrete renosterveld depressions, isolated depressions, isolated seeps, seeps, and valley bottom wetlands.

## 4 LAND-USE AND ECOSYSTEM MANAGEMENT GUIDELINES

The following land-use and ecosystem guidelines have been adapted from the C.A.P.E. fine-scale conservation plans generated for nine municipalities in the Western Cape (Snaddon et al., 2008). They have been summarised and tabulated. A set of general guidelines, applicable to all wetlands within the City, is provided and followed (Table 11) by a more detailed set of guidelines, structured according to the impact category and broad Biodiversity Category in such a way as to highlight the differences between the recommendations for CBA versus ESA wetlands.

### 4.1 General guidelines

- For all development or permit applications, should the activity impact on a wetland, of any description and in any condition, the relevant NEMA EIA regulations (1996) must be followed.
- Wetlands should be protected by a development setback, or buffer, of at least 32m (as stipulated in the NEMA EIA regulations, as the minimum buffer around a wetland within which the regulations will be triggered), ranging up to 75m, as suggested in the City of Cape Town's Floodplain Management Policy (2009). Reasons should be provided to the relevant authorities during the application process (i.e. during the basic or EIA assessment study) where this minimum buffer width is to be reduced.
- The guidelines below shall also be applied to the buffers around wetlands. In other words, the CBA guidelines should apply to CBA buffers.
- Wetlands classified as CBA's should be protected and, where necessary, rehabilitated. Where CBA wetlands have been placed in a condition class that is unacceptable (i.e. lower than a Class C), then these wetlands should be rehabilitated.
- Artificial wetlands should be accorded a level of protection that is in line with their biodiversity value and the ecosystem service provided by the wetland. Artificial wetlands given the status of CESA should be protected by a buffer of at least 32m, but which can be wider, if deemed necessary by a wetland ecologist. Buffers around CESA artificial wetlands can be used for stormwater detention and other activities and services, to the satisfaction of a wetland ecologist. Artificial wetlands given the status of an OESA should be protected by a buffer of at least 10m, but these wetlands must still be assessed and

ground-truthed by a wetland ecologist. Their importance might be related firstly to the service that they provide, with biodiversity value being of secondary importance, but these wetlands may be providing essential ecosystem services.

**Table 11 Land-use and ecosystem management guidelines for CBA (both CBA1 and CBA2) and CESA, and OESA wetlands in the City of Cape Town. CBA = Critical Biodiversity Area; CESA = Critical Ecological Support Area; OESA = Other Ecological Support Area.**

Impact category	CBA and CESA wetlands	Natural and semi-natural OESA wetlands
Water Quantity:	<ul style="list-style-type: none"> <li>There should be no change in the natural hydrology of a CBA or CESA wetland – e.g. from seasonal to perennial, or from ephemeral to seasonal. In the case of naturally ephemeral systems, decreases in flow could result in their alteration to mainly terrestrial systems, characterised by weedy vegetation, with a loss of wetland function. Increases in surface and/or groundwater inflows could lead to changes in plant structure, e.g. an increase in hardy sedges and reeds or bulrushes, and a decrease in seasonal wetland vegetation communities. There may be changes in plant zonation e.g. increased width of wet bank <i>versus</i> dry bank vegetation, or a loss of important seasonally inundated breeding areas (e.g. inundated sedge habitat used by larvae of many invertebrate taxa).</li> </ul>	<ul style="list-style-type: none"> <li>There should preferably be no change in the natural hydrology of an OESA wetland – e.g. from seasonal to perennial, or from ephemeral to seasonal.</li> </ul>
	<ul style="list-style-type: none"> <li>There should be no changes in flooding frequencies and magnitudes as this would modify the extent and duration of wetland inundation - decreases in duration and frequency of inundation may have implications for the value of certain wetland habitats as breeding sites for wetland fauna, may reduce scour, leading to encroachment by aquatic and marginal vegetation, and channel narrowing, leading to loss of wetland function (e.g. erosion protection, sediment trapping and flood detention) during extreme high flow events.</li> </ul>	<ul style="list-style-type: none"> <li>Allowable changes in flooding frequencies and magnitudes should be determined based on the condition of the OESA wetlands, and its links with other ecosystems. Flooding and inundation of OESA wetlands that are linked to CBA or CESA wetlands shall not be altered.</li> </ul>
	<ul style="list-style-type: none"> <li>No stormwater or irrigation return flows shall be conveyed into a CBA or CESA wetland. Runoff should be directed elsewhere or treated</li> </ul>	<ul style="list-style-type: none"> <li>Stormwater or irrigation return flows shall not be conveyed directly into an OESA wetland, unless it is designed for this</li> </ul>

Impact category	CBA and CESA wetlands	Natural and semi-natural OESA wetlands
	<p>outside of the wetland and its buffer, such that it is dissipated to a degree where it has no impact on wetland water quality or hydrology. Buffers around CESA wetlands may be used for this purpose.</p>	<p>purpose. Runoff can be treated in an appropriately sized and designed buffer area.</p>
	<ul style="list-style-type: none"> <li>• CBA or CESA wetlands shall not be drained, channelised or infilled.</li> </ul>	<ul style="list-style-type: none"> <li>• Natural and semi-natural OESA wetlands shall not be drained, channelised or infilled.</li> </ul>
	<ul style="list-style-type: none"> <li>• If the condition or function of a CBA or CESA wetland is impacted or threatened by water abstraction, the current condition of the wetland should be ground-truthed using a preferred method of assessment – currently, this is WET-Health and / or WET-EcoServices or the rapid Wetland Index of Habitat Integrity (for valley bottom and floodplain wetlands). This assessment will feed into the determination of the appropriate Ecological Management Class for the wetland, which is required for the calculation of the water quantity component of the Ecological Reserve for the wetland.</li> </ul>	<ul style="list-style-type: none"> <li>• If the condition or function of an OESA wetland is impacted or threatened by water abstraction and this is deemed by a specialist to be unacceptably detrimental to other important ecosystems, the current condition of the wetland should be ground-truthed using a preferred method of assessment – currently, this is WET-Health and / or WET-EcoServices or the rapid Wetland Index of Habitat Integrity (for valley bottom and floodplain wetlands). Should the assessed condition be unacceptably low, and rehabilitation warranted, then the Ecological Reserve for the wetland shall be determined.</li> </ul>
	<ul style="list-style-type: none"> <li>• No abstraction that results in a lowering of Ecological Management Class (i.e. wetland condition) shall be allowed.</li> </ul>	<ul style="list-style-type: none"> <li>• No abstraction that results in a lowering in Ecological Management Class (i.e. wetland condition) shall take place.</li> </ul>
<b>Groundwater:</b>	<ul style="list-style-type: none"> <li>• Wetlands may rely on groundwater in groundwater discharge areas, thus there should be no abstraction of groundwater allowed within the wetland and its buffer (e.g. wellpoints). Groundwater-fed wetlands may be influenced by groundwater abstraction or diversion far from the wetland itself. The abstraction buffer should be at least 100m in groundwater recharge areas and 250m in groundwater discharge areas.</li> </ul>	<ul style="list-style-type: none"> <li>• Limited abstraction (determined in conjunction with an ecologist and hydrogeologist) shall be allowed from wetlands and their buffers known to rely on groundwater as a water source.</li> </ul>
	<ul style="list-style-type: none"> <li>• Some wetlands may be critical for groundwater recharge. Inundation of the wetland must be allowed to occur – refer to “water quantity” guidelines.</li> </ul>	
<b>Water quality:</b>	<ul style="list-style-type: none"> <li>• There should preferably be no increases in pH (especially in seeps), salinity and/or nutrients in</li> </ul>	<ul style="list-style-type: none"> <li>• Changes in pH, salinity and/or nutrient concentrations in OESA wetlands should be minimised, and</li> </ul>

Impact category	CBA and CESA wetlands	Natural and semi-natural OESA wetlands
	<p>incoming runoff, as this will affect wetland habitat quality – increased nutrients might result in the creation of eutrophic and potentially oxygen depleted habitats; increased pH or salinities above key threshold levels might result in changes in plant zonation and community structure and a proliferation of weedy elements. Seasonal variability in water quality must be retained, especially in seasonally inundated wetlands.</p>	<p>should not exceed natural fluctuations by more than 15% (as stipulated in DWEA’s Water Quality Guidelines).</p>
	<ul style="list-style-type: none"> <li>Water quality should be maintained as close to <b>natural or near natural</b> as possible (Eco-status / Ecological Management Class A or B).</li> </ul>	<ul style="list-style-type: none"> <li>If the condition or function of an OESA wetland is impacted or threatened by deterioration in water quality and this is deemed by a specialist to be unacceptably detrimental to the wetland and / or other important ecosystems, the current condition of the wetland should be ground-truthed using a preferred method of assessment – currently, this is WET-Health and / or WET-EcoServices or the rapid Wetland Index of Habitat Integrity (for valley bottom and floodplain wetlands, although the water quality module was incomplete as of July 2009). Should the assessed condition be unacceptably low, and rehabilitation warranted, then the Ecological Reserve for the wetland shall be determined, in order to inform water quality guidelines for the wetland.</li> </ul>
	<ul style="list-style-type: none"> <li>No waste (including treated waste) or water containing waste to be discharged into CBA or CESA wetlands.</li> </ul>	<ul style="list-style-type: none"> <li>No waste (including treated waste) or water containing waste to be discharged directly into an OESA wetland, unless it is designed to accommodate such waste. If the wetland is natural or semi-natural, stormwater runoff must meet the requirements for Sustainable Urban Drainage Systems, as described in the City of Cape Town’s Policy on Minimising the Impact of Stormwater from Urban Development On Receiving Waters.</li> </ul>
	<ul style="list-style-type: none"> <li>DWEA’s National Water Resource Classification process is the vehicle through which the</li> </ul>	<ul style="list-style-type: none"> <li>DWEA’s National Water Resource Classification process is the vehicle through which the</li> </ul>

Impact category	CBA and CESA wetlands	Natural and semi-natural OESA wetlands
	<p>Resource Water Quality Objectives (RWQO's) are set, and through which the water quality component of the Ecological Reserve is determined. This must be strictly applied for all CBA or CESA wetlands. For wetlands associated with rivers, the RWQO's set for the associated river can be used.</p>	<p>Resource Water Quality Objectives (RWQO's) are set, and through which the water quality component of the Ecological Reserve is determined. This should be applied to OESA wetlands that are linked to CBA or important CESA wetlands. for all CBA or CESA wetlands.</p>
	<ul style="list-style-type: none"> <li>• A precautionary approach is required to protect the health of aquatic ecosystems, which means that active measures are taken to avert or minimise the potential risks of undesirable impacts on the environment.</li> </ul>	<ul style="list-style-type: none"> <li>• A precautionary approach is required to protect the health of aquatic ecosystems, which means that active measures are taken to avert or minimise the potential risks of undesirable impacts on the environment.</li> </ul>
<b>Sedimentation and erosion:</b>	<ul style="list-style-type: none"> <li>• Modifications to the bed and banks of the wetland shall be prohibited. No excavation and / or removal of soil / sand or cobbles allowed, even if this does not exceed 5m<sup>3</sup>.</li> </ul>	<ul style="list-style-type: none"> <li>• Modifications to the bed and banks of the wetland shall be regulated. Excavation and / or removal of soil / sand or cobbles shall not exceed 5m<sup>3</sup> but if it must exceed this amount, then at least a basic assessment, as stipulated in the EIA regulations (2006) must be done.</li> </ul>
	<ul style="list-style-type: none"> <li>• Livestock shall preferably not have access to a CBA or CESA wetland.</li> </ul>	<ul style="list-style-type: none"> <li>• Livestock shall only have access to OESA wetlands outside of the growing season.</li> </ul>
	<ul style="list-style-type: none"> <li>• CBA or CESA wetlands should be protected from concentration of flows as a result of bridges, channelisation, pipes or culverts. These should preferably not be allowed to cross CBA or CESA wetlands, as they lead to erosion through the creation of nick points. This is particularly so for unchanneled valley bottom wetlands and seeps. Where crossings are in existence they must allow for adequate spread of flows through multiple surface and subsurface pipes and culverts across the full width of the wetland.</li> </ul>	<ul style="list-style-type: none"> <li>• OESA wetlands should be protected from concentration of flows as a result of bridges, channelisation, pipes or culverts. Where these must occur within a wetland, flow must be dispersed through multiple surface and subsurface pipes and culverts across the full width of the wetland.</li> </ul>
	<ul style="list-style-type: none"> <li>• Agricultural activities around CBA or CESA wetlands shall preferably be limited to extensive and not intensive agriculture, and shall not encroach into the CBA or CESA wetland buffer. Buffers shall be designed to reduce the impacts of surrounding agricultural activities.</li> </ul>	<ul style="list-style-type: none"> <li>• Buffers around OESA wetlands should be designed to reduce the impacts of surrounding agricultural activities.</li> </ul>
<b>Connectivity:</b>	<ul style="list-style-type: none"> <li>• Some wetlands are influenced by</li> </ul>	<ul style="list-style-type: none"> <li>• Some wetlands are influenced by</li> </ul>

Impact category	CBA and CESA wetlands	Natural and semi-natural OESA wetlands
	<p>riverine processes. Thus, they are sensitive to upstream activities and activities in the catchment as a whole. CBA or CESA wetlands should not be treated as isolated features but should be incorporated into catchment-wide conservation plans or programmes.</p>	<p>riverine processes. Thus, they are sensitive to upstream activities and activities in the catchment as a whole. OESA wetlands shall be managed within the context of catchment-wide management plans or programmes.</p>
	<ul style="list-style-type: none"> <li>Some wetlands are closely associated with estuarine systems. Thus, activities occurring on and around a wetland must take into account downstream impacts.</li> </ul>	<ul style="list-style-type: none"> <li>Some wetlands are closely associated with estuarine systems. Thus, activities occurring on and around a wetland must take into account downstream impacts.</li> </ul>
	<ul style="list-style-type: none"> <li>The extent of wetlands is not always readily discernible (for instance where the extent of inundation of the wetland fluctuates widely) so they are vulnerable to constriction and encroachment by agricultural activities, roads, urban development. Development that encroaches on a CBA or CESA wetland or its buffer must be subject to a basic assessment or EIA.</li> </ul>	<ul style="list-style-type: none"> <li>Development that encroaches on an OESA wetland or its buffer must be subject to a basic assessment.</li> </ul>
	<ul style="list-style-type: none"> <li>CBA or CESA wetlands shall not be fragmented or reduced in extent. These wetlands can perform an important function as natural ecological corridors, allowing movement of fauna and flora within the landscape, as well as providing many other goods and services (such as flood attenuation, erosion control).</li> </ul>	<ul style="list-style-type: none"> <li>Activities that threaten to fragment or reduce the extent of an OESA wetland must be subject to a basic assessment or full EIA, depending on the nature of the activities.</li> </ul>
	<ul style="list-style-type: none"> <li>CBA or CESA wetlands shall not be impounded. This could lead to deepening of these often shallow systems, and so a change in the natural character of the wetland, with consequent changes in the wetland fauna and flora. Flood control berms should not be placed in or close to CBA or CESA wetlands.</li> </ul>	<ul style="list-style-type: none"> <li>Impoundment or any activity that will alter flow into or through an OESA wetland must be subject to at least a basic assessment.</li> </ul>
	<ul style="list-style-type: none"> <li>No roads shall be constructed through a CBA or CESA wetland. Construction of bridges over CBA or CESA wetlands must be strictly controlled, and must go through the full EIA process. Bridges should span the entire wetland</li> </ul>	<ul style="list-style-type: none"> <li>Road crossings across OESA wetlands shall be minimised, and all other alternatives investigated. Construction of bridges over OESA wetlands must be strictly controlled, and must go through</li> </ul>

Impact category	CBA and CESA wetlands	Natural and semi-natural OESA wetlands
	area.	the full EIA process.
	<ul style="list-style-type: none"> <li>Water flow through a CBA or CESA wetland shall not be constricted through culverts or pipes, for any reason. There should be no canalisation or channelisation of flow into, through or out of the wetland.</li> </ul>	<ul style="list-style-type: none"> <li>Any activity that will alter the flow of water into and through an OESA wetland must be subject to at least a basic assessment.</li> </ul>
	<ul style="list-style-type: none"> <li>Where a road or other water channeling structure must run through or close to a CBA or CESA wetland, runoff should be discharged through multiple discharge points with energy-dispersing structures. These drains must be small, dispersed low-volume, low-velocity structures. They must preferably discharge into vegetated areas outside of the wetland and its buffer, at ground level.</li> </ul>	<ul style="list-style-type: none"> <li>Where a road or other water channeling structure must run through or close to an OESA wetland, runoff should be discharged through multiple discharge points with energy-dispersing structures. These drains must be small, dispersed low-volume, low-velocity structures. They must preferably discharge into vegetated areas outside of the wetland and its buffer, at ground level.</li> </ul>
<b>Flora and fauna:</b>	<ul style="list-style-type: none"> <li>City of Cape Town / CapeNature / SANParks (or other relevant conservation body) should investigate the establishment of fish, amphibian and invertebrate sanctuary areas and aquatic reserves in and around CBA or CESA wetlands.</li> </ul>	
	<ul style="list-style-type: none"> <li>There shall be no impoundment of wetlands, as these structures restrict the movement of fish and invertebrates and alter inundation characteristics (flood duration etc).</li> </ul>	<ul style="list-style-type: none"> <li>Impoundment or any activity that will alter flow into or through an OESA wetland must be subject to at least a basic assessment.</li> </ul>
	<ul style="list-style-type: none"> <li>CBA or CESA wetlands shall not be stocked with alien fish (and any other fauna) or alien plants.</li> </ul>	<ul style="list-style-type: none"> <li>OESA wetlands shall not be stocked with alien fish (and any other fauna) or alien plants.</li> </ul>
	<ul style="list-style-type: none"> <li>The possibility of the eradication and control of alien fish populations should be investigated in CBA or CESA wetlands.</li> </ul>	<ul style="list-style-type: none"> <li>The possibility of the eradication and control of alien fish populations should be investigated in OESA wetlands.</li> </ul>
	<ul style="list-style-type: none"> <li>Alien and invasive plants shall be cleared within and around the CBA or CESA wetland.</li> </ul>	<ul style="list-style-type: none"> <li>Alien and invasive plants shall be cleared within and around the OESA wetland.</li> </ul>
	<ul style="list-style-type: none"> <li>Fences should not be erected around or through CBA or CESA wetlands.</li> </ul>	<ul style="list-style-type: none"> <li>Fences should preferably not be erected around or through CBA wetlands. Where they must be built through a wetland, the fence must be permeable for the movement of fauna and flora across the wetland.</li> </ul>

Impact category	CBA and CESA wetlands	Natural and semi-natural OESA wetlands
Overall Management:	<ul style="list-style-type: none"> <li>CBA or CESA wetlands should be managed as close to <b>natural or near natural</b> as possible (Eco-status / Ecological Management Class A or B).</li> </ul>	<ul style="list-style-type: none"> <li>OESA wetlands should be managed for the maintenance of ecological functioning within and around the wetland.</li> </ul>
	<ul style="list-style-type: none"> <li>No lowering of Ecological Management Class (i.e. wetland condition) should be allowed, and the wetland should be actively rehabilitated to Class A, B or C if currently assessed as being lower than a Class C.</li> </ul>	<ul style="list-style-type: none"> <li>No decline in Ecological Management Class (i.e. wetland condition) should be allowed.</li> </ul>
	<ul style="list-style-type: none"> <li>Conservation of biodiversity is to be considered the highest priority user, in terms of the Ecological Reserve.</li> </ul>	
	<ul style="list-style-type: none"> <li>Where CBA or CESA wetlands are potentially affected by a new development or activity, the wetland must be accurately delineated, using the DWEA delineation protocol (DAAF, 2005), and a suitable buffer established.</li> </ul>	<ul style="list-style-type: none"> <li>Where an OESA wetland is threatened by any activity, the wetland must be accurately delineated, using the DWEA delineation protocol (DAAF, 2005), and a suitable buffer established.</li> </ul>
	<ul style="list-style-type: none"> <li>The condition of the wetland should be determined using the current preferred method of assessment – currently, this is WET-Health and / or WET-EcoServices, or the rapid Wetland Index of Habitat Integrity (for valley bottom and floodplain wetlands). This assessment will feed into the determination of the appropriate Ecological Management Class for the wetland, which is required for the calculation of the water quantity and water quality components of the Ecological Reserve for the wetland.</li> </ul>	
	<ul style="list-style-type: none"> <li>Resource Quality Objectives (RQOs) should be set for CBA or CESA wetlands.</li> </ul>	

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## APPENDIX 1 DESCRIPTION OF THE WETLAND TYPES

### *Alluvium fynbos wetlands*

The alluvium fynbos wetlands are situated predominantly in the Lourens River catchment in the Somerset West area, lying within the Lourensford alluvium fynbos vegetation unit. The wetlands are dominated by non-isolated hillslope and basin seeps, which occupy the lower-lying slopes (below approximately 200mAMSL) of the catchment. The soils tend to be silty soils, often over granite, Malmesbury Group metasediments, or sandstones – the soils often are embedded with cobbles, pebbles and gravel (Rebelo *et al.*, 2006). The wetlands are vegetated with sedges, such as *Bolboschoenus maritimus*, rushes, such as *Juncus kraussi* and grasses, such as *Pennisetum macrourum* and *Cynodon dactylon*. The halophytic *Sarcocornia* sp. (possibly *natalensis*) is also found in the wetland depressions and valley bottom wetlands.

The wetlands that were ground-truthed (4 wetlands) were found to be in a poor condition – ranging from a Class C to Class E. The Lourens River catchment has been farmed for centuries, and so the soils and ecosystems have been heavily modified through grazing, ploughing, frequent fires and, more recently, industrial and residential development.

Alluvium fynbos seeps are considered to be of high sensitivity, and the depressions, floodplain and valley bottom wetlands of moderate sensitivity. All of the alluvium fynbos wetlands are subject to a high level of threat, and are likely to be of high conservation importance, due to the low level of present preservation of land within this vegetation unit.



**Photo 1** An alluvium fynbos hillslope seep (KS0298), dominated by *Pennisetum macrourum*.

### *Alluvium renosterveld wetlands*

Only one alluvium renosterveld was mapped – an alluvium renosterveld valley bottom wetland, associated with the middle reaches of the Diep River. The wetland occurs in Swartland Alluvium Renosterveld, which is a vulnerable vegetation type. This wetland was not ground-truthed, and very little information is known about this wetland type. The soils underlying the vegetation type are predominantly fine silty and sandy alluvial sediments, derived mainly from granite (Rebelo *et al.*, 2006). The wetland lies outside of the Biodiversity Network, on land that has been severely modified by agricultural activities such as ploughing.

### *Dune strandveld wetlands*

Dune strandveld wetlands comprise mostly depressions – many of which are typical duneslack wetlands – followed by floodplains and seeps, and a few valley bottom wetlands. These wetlands are located primarily on the Cape Flats, in a triangle that extends from the False Bay coast between Muizenberg and Gordons

Bay, up to Bellville. Others are scattered between dunes along the west coast of the Peninsula, within the Table Mountain National Park. The Cape Flats Dune Strandveld vegetation types occupy the low-lying parts of the City (generally 0 – 80mAMSL), and grow in soils that are calcareous sands of marine origin. The dune strandveld wetlands that are in the best condition are mostly the isolated depressions, or duneslack wetlands, which typically support a good mix of wetland grasses (such as *Imperata cylindrical*), sedges (such as *Ficinia* spp.), asteraceous shrubs (such as *Senecio halimifolius*) and restios. The undisturbed floodplain and valley bottom wetlands are vegetated with sedges, restios, *Berzelia* spp. and *Leucadendron* spp.

These wetlands are highly threatened by infilling for development, stormwater discharge, alien invasion, and fragmentation through road construction.

Together, the dune strandveld wetlands make up 23.5% of the total area of natural and semi-natural wetlands in the City of Cape Town. 121 wetlands of this type were visited in the field.



**Photo 2 Cape Flats dune strandveld depressional wetland (KS1874), dominated by *Imperata cylindrical*.**



**Photo 3 Dune strandveld depression (JES1569) near Strandfontein, showing rushes, sedges and *Imperata cylindrical*.**

### **Granite fynbos wetlands**

Granite fynbos wetlands are mostly hillslope and basin seeps, occurring on the slopes of the Helderberg Mountains near Somerset West and Stellenbosch, and the lower slopes of the Peninsula. Boland and Peninsula (North and South) granite fynbos occurs on the lower slopes of the City's mountains, below the upper sandstone slopes, on deep, loamy, granite-derived sandy soils. The less disturbed wetlands are inhabited by wetland grasses (primarily *Cynodon dactylon*), restios and some sedges and rushes (*Juncus kraussii*). Many of these wetlands have been impacted by infilling and excavation, alien invasion (especially kikuyu), input of stormwater and the loss of natural wetland vegetation.

Granite fynbos wetlands account for 9% of the City's natural and semi-natural wetlands. Thirty-three of these wetlands were ground-truthed.



**Photo 4** A granite fynbos seep on the lower slopes of Hout Bay valley (KS0739).

### ***Granite renosterveld wetlands***

Granite renosterveld wetlands occur in the Swartland Granite Renosterveld vegetation type, which is critically endangered. The wetlands, mainly seeps and valley bottom wetlands associated with river channels, are located in four separate areas – in the far north of the City, associated with the Louwskloof River, in the Joostenberg area around the R312, around the middle reaches of the Bottelary River, and the upper reaches of the Eerste/Kuils catchment. All occur on coarse sandy to loamy granite-derived soils, which tend to retain moisture during the wet months (Rebelo *et al.*, 2006).

All of the 6 granite renosterveld wetlands visited during ground-truthing were in poor condition (less than or in a Class C), mainly as a result of agricultural activities such as ploughing and grazing. Most of them were found to support stands of reeds and bulrush, with few other wetland sedges and grasses. Many were invaded by woody aliens such as poplars, pines and oaks.

### ***Sand fynbos wetlands***

Sand fynbos wetlands are predominantly depressions and seeps, followed closely by floodplain wetlands. These wetland types account for the highest proportion of wetlands in the City - over 34%. They are found on low-lying (below 200m) lands, on deep, acid sands throughout the City. Cape Flats Sand Fynbos is critically endangered, while Hangklip and Atlantis Sand Fynbos are vulnerable.

These wetlands tend to be dominated by restios and sedges, but are often invaded by reeds and bulrush. They are threatened by impacts such as stormwater discharge, fragmentation through the construction of roads and bridges, invasion of aliens and invasives, and other impacts associated with urban areas. 151 sand fynbos wetlands were ground-truthed.



**Photo 5 Sand fynbos depression, at Kenilworth Racecourse (VRG0317).**



**Photo 6 Sand fynbos depression (KS1838) at Wynberg Sports Precinct, surrounded by roads and heavily invaded by kikuyu.**

### ***Sandstone fynbos wetlands***

Sandstone fynbos wetlands comprise depressions, seeps (which are the most numerous) and valley bottom wetlands. Together, these wetlands account for 12% of the total area of natural and semi-natural wetlands in the City. They are located on gentle to steep slopes in the Peninsula mountains and the mountains around Steenbras Dam, and so are largely conserved in Protected Areas. As a result, the vegetation types in which these wetlands occur are considered to be least threatened by land transformation (the conservation status of these vegetation types will be changed in the 2008 NEMBA to endangered for Peninsula Sandstone Fynbos and critically endangered for Kogelberg Sandstone Fynbos, due to the high concentrations of Red Data List plant species in these types). The soils are acidic and sandstone-derived.

Twenty-three of the sandstone fynbos wetlands were ground-truthed, most of which were in an A or B Class, in terms of wetland condition. These wetlands are dominated by *Berzelia* spp. and *Leucadendron* spp., with several species of *Ericas* and restios. A common plant inhabitant is *Psoralea pinnata*.



**Photo 7** Mixed *Berzelia* and *Leucadendron* plant community in a sandstone fynbos hillslope seep.

### **Shale band wetlands**

There are five shale band seeps in the City – all of these occur above Steenbras Dam, so, like the sandstone fynbos wetlands, these are protected. The wetlands occur on clayey soils, derived from shale, and are dominated by *Berzelia* spp. and *Leucadendron* spp. and various indigenous grasses. Four of these wetlands were ground-truthed and were found to be in good condition – either an A or B Class.



**Photo 8** A burnt shale band hillslope seep above Steenbras Dam (JES2992), showing *Berzelia lanuginosa*-dominated community.

### **Shale fynbos wetlands**

Shale fynbos wetlands comprise only seeps and valley bottom wetlands, but mostly hillslope seeps, which occur on the high-lying slopes of mountains in the City – such as Devil's Peak, and the Steenbras Mountains. Shale fynbos vegetation types – these are Peninsula, Elgin and Winelands Shale Fynbos – occur on well-leached soils derived from shale. They appear to be dominated by grasses and sedges.

Five shale fynbos wetlands were visited in the field, but all were in a poor condition, largely as a result of agricultural activities in the area and heavy alien infestation.



**Photo 9** Shale fynbos hillslope seep (KS1776) below the N2 at Sir Lowry's Pass, dominated by sedges and grasses.

### ***Shale renosterveld wetlands***

Shale renosterveld wetlands include depressions, floodplain wetlands, seeps (the majority) and valley bottom wetlands. The two vegetation types in which they occur are both critically endangered, and most of the wetlands are located outside of the City's Biodiversity Network. These vegetation types are located on clayey soils derived from shales.

Only one of the 27 shale renosterveld wetlands that were ground-truthed was found to be in good condition – this wetland supported a good mix of wetland plants including sedges such as *Bolboschoenus maritimus*, restios such as *Chondropetalum rectum*, and rushes and grasses. Most of the wetlands visited were heavily impacted by farming practices, fragmentation, channelisation, and alien invasion (especially kikuyu and poplars). Many are now dominated by reeds and bulrushes.



**Photo 10** A shale renosterveld seep (NJ0491) invaded by poplars.

### ***Silcrete renosterveld wetlands***

Only 9 scattered silcrete renosterveld wetlands were mapped – 7 are seeps and 2 are valley bottom wetlands. These wetlands occur on remnant silcrete layers on shales and granites (Rebelo *et al.*, 2006). Only one of these wetlands was visited in the field, and was found to be in a very poor state (F Class), as a result of ploughing.



**Photo 11 The remnants of a silcrete renosterveld seep (KS0243).**

### ***Cape estuaries***

The City Wetlands Map includes Cape estuarine channels, depressions and river mouths, as defined in the NWICS (Ewart-Smith *et al.*, 2006). These have been mapped at the estuaries of the Diep, Sand, Krom, Schusters, Soet, Bokramspruit, Eerste, Lourens, Hout Bay and Sout Rivers.

None of the estuaries were ground-truthed. They tend to be systems that are a mix of vegetated depressions and flats, and sandy channels. The vegetated areas should naturally be covered with salt-tolerant estuarine species such as *Sarcocornia* spp. and *Salicornia* spp., grasses such as *Cynodon dactylon*, the rush *Juncus kraussii*, and other shrubs and herbs such as *Cotula* spp., *Triglochin* spp. and *Plantago* spp.

Many of the estuaries in the City have been heavily impacted by activities in their catchments. These coastal systems receive polluted water from upstream, with discharge regimes that are not natural. As a result, the City's estuaries are in poor condition, and tend to be dominated by stands of the common reed, *Phragmites australis*, which thrives in these altered conditions.

Estuaries are all considered to be of very high functional importance and ecological sensitivity, and are subject to a very high level of threat, due to their position in the catchment.