Client:
Heartland Properties (Pty) Ltd
Somerset West

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Paardevlei

Operational Phase Environmental Management Plan

FINAL

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City of Cape Town
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Environmental and Heritage Management
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PAARDEVLEI
OPERATIONAL PHASE
ENVIRONMENTAL MANAGEMENT PLAN
REVISED FINAL REPORT: 2013

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1 INTRODUCTION

1.1 Background

Paardevlei is a pivotal component of the Heartlands (former AECI) site in Somerset West. At the time of writing this document, development of the site was still in its planning phase, and the vlei was in the early stages of implementation of a long-term remediation plan, which aims to see the wetland developed as a valuable asset, central to the layout and development of a new urban hub on the site.

Critical to achieving this broad objective on a sustainable basis is the need to ensure that Paardevlei receives adequate management intervention, both in the short and long term. Recognising that management of the system is required on an ongoing basis, Heartland Properties (Pty) Ltd (referred to hereafter as "Heartlands") appointed Freshwater Consulting cc (t/a The Freshwater Consulting Group / FCG) to compile an Operational Phase Wetland Management Plan, that would provide guidance to Heartlands regarding the management requirements and priorities for Paardevlei, as it enters into its operational phase.

1.2 Purpose of this document

This document comprises the first Operational Phase Environmental Management Plan (OEMP) for the Paardevlei wetland. Its purpose is to provide guidelines as to the frequency and nature of management interventions that are required to establish Paardevlei on a desirable trajectory of condition, during its early post-remediation phase, and into the future.

This said, it is stressed at the outset that this management plan has been compiled at an early stage in the establishment of Paardevlei. It is quite likely that, over time, certain issues will present themselves that were not considered in this document. It is also possible that alternative, more practical or cost-effective approaches to addressing certain management issues will also be considered in time. Given these factors, it is recommended that the OEMP should be re-visited on a regular basis in the future, and revised as necessary, without alteration in the overarching management objectives, to take account of changing management challenges and issues. A full review of management requirements is recommended on a five year basis, with the first review scheduled for the start of 2017.

1.3 Informants of the OEMP

This OEMP has been compiled on the basis of recommendations for the long-term hydrological, water quality and land use regime of Paardevlei, first outlined in Day (2009), and subsequently carried through into the conceptual planning, final design and construction phases of Paardevlei (Bau-Afrika *et al* 2010). The objectives and management interventions presented here have moreover largely been developed in iterative discussions with the Heartlands development team, as well as with the stormwater engineer and project landscaper, and have taken cognizance of the assumptions and recommendations outlined in the stormwater master plan for the Heartlands site as a whole (Bau-Afrika 2010). The comments and recommendations of the City of Cape Town's Environmental and Heritage Management (E&HM) Branch, District E on an earlier draft of the OEMP have also been incorporated into this version.

1.4 Wetland systems included in this OEMP

Although the Heartlands site as a whole includes a number of wetland systems and extensive areas of terrestrial habitat of high conservation significance, the OEMP focuses only on the management requirements for Paardevlei itself. It is assumed that this document will however be incorporated into a more holistic document that deals with management issues and recommendations for environmental management on the site as a whole.

1.5 Acknowledgements

Input from the following individuals and organisations into the recommendations outlined in this document is gratefully acknowledged:

- Mr Mark Bezencon (Heartland Properties)
- Mr Beyers Strydom (Heartland Properties)
- Mr Anthony Caldow (GEMS Estate Management)
- Mr Rudy Schwaeble (Bau-Afrika – project stormwater engineer)
- Ms Tanya de Villiers (CnDeV landscape architects)
- Mr Tony Williams (avifaunal specialist).

Figure 1 **Context of Paardevlei in the Heartlands site (yellow outline).**

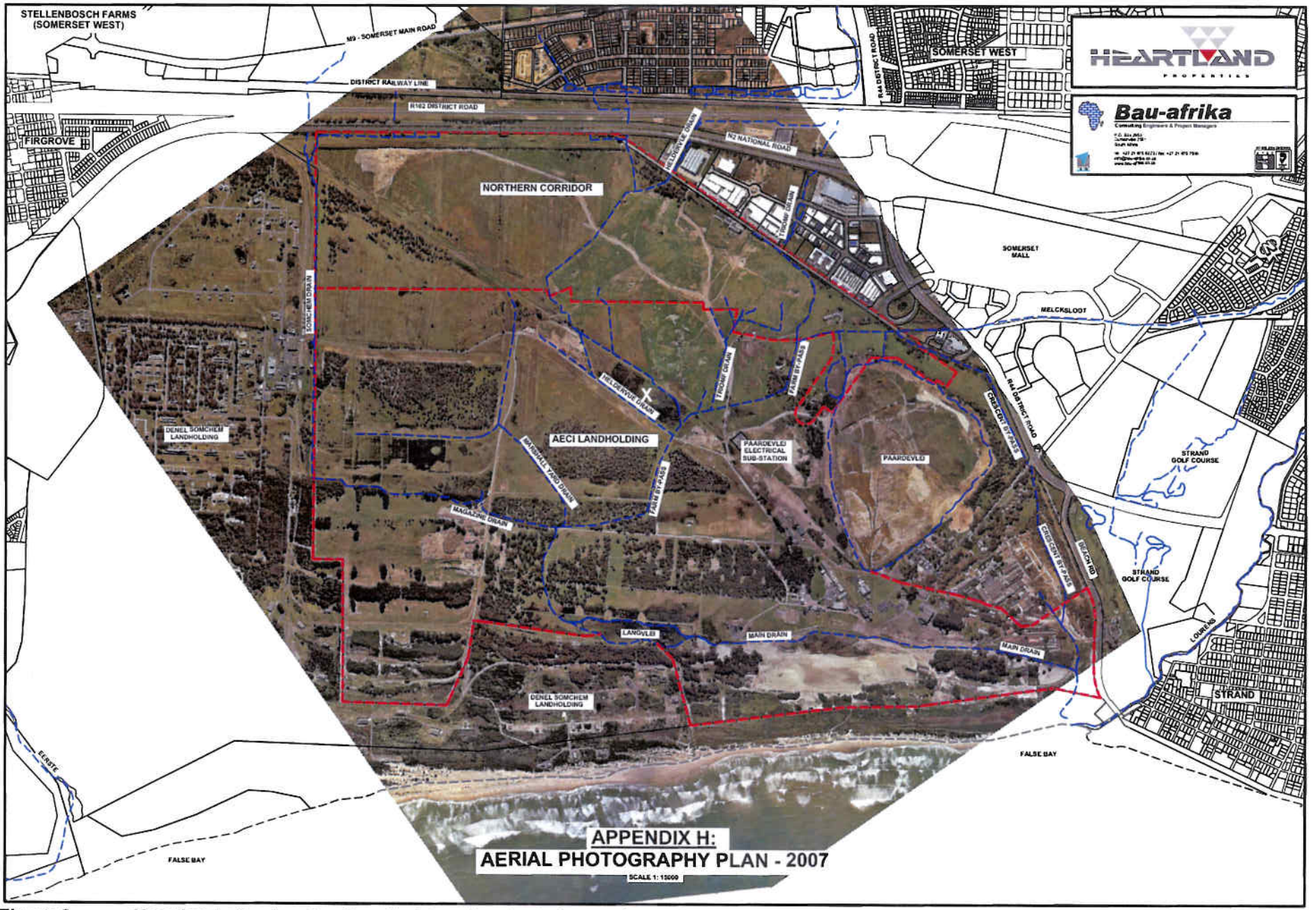

Figure 2 **Heartland site showing Paardevlei and main drainage channels into and through the site. 2007 aerial overlay. Figure marginally adapted from Bau-Afrika (2008) with thanks.**

2 HISTORICAL, ECOLOGICAL, AND HYDROLOGICAL CONTEXTS

2.1 Overview and ecological context

Figure 1 shows Paardevlei and the greater Heartlands site within the context of Somerset West. Figure 2, adapted from Bau-Afrika (2008), summarises major drainage patterns as they exist at present across the site.

The site lies within the catchment area of the Lourens River, which drains into False Bay via its estuary immediately east of the site (Figure 1). Paardevlei links hydrologically to the Lourens River via its outlet into the Main Drain. To the south of the vlei, the Main Drain conveys runoff to the eastern site boundary, where it links with the Crescent Bypass - an artificial drainage channel through the Heartlands site. The combined Main Drain / Crescent Bypass channel passes into the Lourens River at its estuary, via a number of piped culverts, although some flow is dissipated into the large reedbed wetland that has developed on the coastal dunes just above the estuary, referred to in some maps and reports as the Wagenfeldt wetland (e.g. BauAfrika 2010), and in Snaddon (2007) as the coastal flats wetland.

Other important wetlands that occur on the overall Heartlands site, but lie upstream of the flow pathways from Paardevlei itself include the Langvlei, which feeds into the Main Drain upstream of the outlet from Paardevlei, as well as numerous, largely perched wetland flats, that historically once probably covered large areas of the site, but which today have been largely impacted as a result of both activities taking place at the former AECI site, and as a result of subsequent remediation of these activities, including the removal of large volumes of contaminated surface material. These systems are not dealt with further in this document.

However, although the OEMP focuses on the long-term management of Paardevlei itself (see Section 1.4), it does include activities of relevance to the management of some of the abutting wetlands, specifically the wetland depressions and wetland flats immediately east and north east of the vlei, in the area between the vlei and De Beers Ave and the vlei and Broadway Rd, respectively. These wetlands have been identified as potentially important frog habitat by the faunal specialist on the EIA team for the proposed Heartlands Development. The conservation importance of these wetland habitats is potentially higher than that of the highly transformed Paardevlei itself.

2.2 A brief history of changes in the function and form of Paardevlei, in relation to surrounding landuse changes

Under natural conditions, Paardevlei was a seasonally inundated, isolated depressional wetland, which would have received water from a combination of surface and shallow subsurface flows (Snaddon 2007). It was a naturally shallow system, which was artificially deepened and extended by means of low berms during its use as a storage reservoir for the former AECI site. During this time, the vlei was gradually contaminated by heavy metals and nutrients, with the result that by the time that the AECI site was decommissioned, the vlei was hypertrophic, subject to frequent blooms of so-called blue-green algae and underlain by thick sludges of contaminated sediment. Despite this, the relatively deep waters of the vlei supported a large population of fish (primarily Carp), and numerous aquatic birds (Harding 2006).

One of the remediation measures that was carried out on the former AECI site was the removal of carp from the water body, using the piscicide Rotenone. This took place in 2005. Subsequently, during early phases of development planning around the use of the broader site, now known as the Heartlands Site, the vlei was drained, and dredged, with the objective both of removing years' worth of contaminated sediments and deepening sections of the vlei. The berms themselves were also largely removed in 2007/2008, to improve wetland habitat along the vlei edges and to improve visual access from the surrounding development (Dewar

and Louw 2007).

Although initial plans were developed around proposals to manage Paardevlei as an open water recreational lake, with water of a high enough quality to meet full contact recreational standards (Harding 2006), concerns around the long-term sustainability of such a system, and the high costs of and treatment of a permanent water supply into the vlei, resulted in this long-term management objective being shelved in favour of a more pragmatic approach, outlined in Section 3.1 of this report. The new approach essentially would entail re-design and management of Paardevlei as a shallow, seasonally inundated, reedbed- dominated inland water body (Day 2009).

2.3 Water supply

Historically, the Paardevlei was filled via the Melck Sloot with water abstracted from the Lourens River. The Melck Sloot is an historic irrigation furrow, considered to be a significant heritage resource that has formed a feature in the historic landscape since the late 18th Century (Attwell 2007). It was constructed to convey irrigation water to various farms and other land users in the area. Water is diverted from the Lourens River into the Melck Sloot immediately downstream of the N2, by means of an adjustable sluice gate set in a concrete weir across the Melck Sloot channel (Arcus Gibb 2005).

At the time of writing this report, Heartlands retained water use rights from the Lourens River, but between 2006 and 2010, the Paardevlei was inundated primarily by local precipitation, and the Melcksloot connection was not utilised.

In 2011, Paardevlei's water supply was supplemented with inflows from the Crescent Bypass channel. This artificial stormwater channel drains a catchment of some 66ha, to the north west of Paardevlei (Bau-Afrika 2010). The channel originally bypassed the vlei, passing beneath De Beers Avenue and running along the eastern boundary of the Heartlands site, as far as its confluence with the Main Drain. However, taking cognizance of the apparently good quality of runoff in the upper reaches of the Crescent Bypass adjacent to Paardevlei, during the course of 2011 its upper reaches were diverted into the vlei, via an excavated channel from the south eastern edge.

Current development proposals for the Heartlands site show that, assuming that Environmental Impact Assessment (EIA) and other development applications are approved by the relevant authorities, Paardevlei would also receive runoff from the Heldervue Channel (see Figure 2). This channel drains a catchment area of some 85ha to the north of Paardevlei, and lies primarily outside of the Heartlands site, extending north of the N2 and west of Helderberg College Road (Bau-Afrika 2010). Day (2009) suggested that the quality of water entering the Heartlands site via the Heldervue Channel was at times polluted, with problem variables including elevated concentrations of phosphorus and ammonia.

- be supplied with water from a combination of sources, including local precipitation and stormwater generated both on the site itself and also, potentially, from stormwater sources off-site (e.g. the Heldervue Canal);
- be largely independent of water allocations from the Lourens River via the Melck Sloot, although such water, if available, would constitute a useful means of providing annual wet-season flushing of the vlei as well as facilitating initial filling of the vlei;
- include links to other wetland and terrestrial areas on and associated with the Heartlands site, which would promote ecological connectivity. The most significant of these is considered to be the proposed links to the Langvlei and Lourens River, via the Main Drain (Figure 2), as well as links to east-west corridors running along the boundary of the site, adjacent to the N2;
- incorporate a broad (artificially created) ecological buffer area between the wetland edge and the development along the southern edge of the vlei, formed by infilling the vlei margins so as to create a gentle grade between terrestrial habitat and seasonally inundated wetland margins, suitable for use as an ecological corridor around the vlei, as well as for creating a setback area between the wetland and impacts derived from human activities taking place on the adjacent development.

The rehabilitated wetland, in terms of the above scenario, would comprise a wetland that was:

- highly suitable for passive recreational activities, including birdwatching and walking;
- periodically suitable, in limited areas, for activities such as canoeing, which would be most practical during the wet season, but would probably require active management of portions of the reedbed to allow the passage of canoes;
- unsuitable for any contact recreational activities (from a human health perspective);
- unsuitable for fishing, since seasonal drawdown of the water would reduce fish numbers and, moreover, angling opportunities are likely to result in the introduction of undesirable fish, such as Carp, to the system.

3 DESIGN CONCEPT AND ENABLING SPECIFICATIONS FOR PAARDEVLEI

3.1 Background to the development of a design concept

Day (2009) reviewed a number of design alternatives for Paardevlei. Taking cognizance of experiences at a number of other urban water bodies in South Africa, the study assessed each design alternative from the perspective of long-term risks to sustainability. Poor water quality was identified as the greatest threat to the sustainability of open water bodies and to their potential to contribute to the economic and aesthetic value of their surroundings, with odours, blue-green algal scums, sedimentation and litter all being common outcomes of a failure to achieve and sustain acceptable water quality conditions in the systems. Conflict with residents and local communities over the management of water bodies to meet various conflicting recreational and ecological objectives (e.g. fish stocking, maintenance of open water for boating etc) were also common issues, while all systems were affected by management that, at various times, failed to implement adequate water quality monitoring and water body management systems, and as a result did not identify critical thresholds of impact timeously.

The results of the review provided a background against which Day (2009) assessed the ecological, aesthetic and human health implications of a number of different development scenarios for Paardevlei itself, and compiled recommendations for a future managed wetland system, which would meet a number of broad criteria. At a broad scale, it was recommended that the long-term vision for the wetland should allow for a system that is:

- economically feasible to maintain
- ecologically robust and
- contributes to broader wetland conservation on the Heartlands site.

At the same time, it was noted that future uses of and in the vicinity of the vlei should:

- address safety and security issues associated with their location adjacent to large areas of open space;
- be robust in the face of changing ecological conditions;
- provide real conservation of important natural areas on the site; and
- be legally compliant.

In order to meet the above broad criteria, and drawing on the findings of the review of existing urban water bodies, Day (2009) investigated a number of different water quality and inundation regimes for Paardevlei and recommended a system that was considered most practicable from an implementation perspective, would result in an ecologically desirable outcome, particularly from a wetland conservation and biodiversity perspective, and which would be most robust in a development context, where water quality and quantity are likely to vary over time. The recommended system would comprise a shallow, seasonally inundated wetland pan, with only limited areas of perennial standing water. Maximum wet season depths would be likely to be in the order of 1.8 to 2m (limited areas only), which would drop to summer lows of 0.8 to 1m deep only. Most of the wetland would however comprise far shallower expanses of water (Figure 3).

Heartlands have accepted the above design concept, the details of which were presented to the development team in Bau-Afrika *et al.* (2010).

3.2 Ecological design specifications for Paardevlei

The approved design concept for Paardevlei complies with the following ecological specifications, outlined in Bau-Afrika *et al* (2010) on the basis of recommendations made in Day (2009). Specifically, the wetland should:

- comprise mainly extensive areas of emergent reeds, but include a diversity of other wetland habitat types, as outlined in Figure 3;
- be edged, on all but its western edge, by broad expanses of seasonally shallowly inundated sedge habitat;

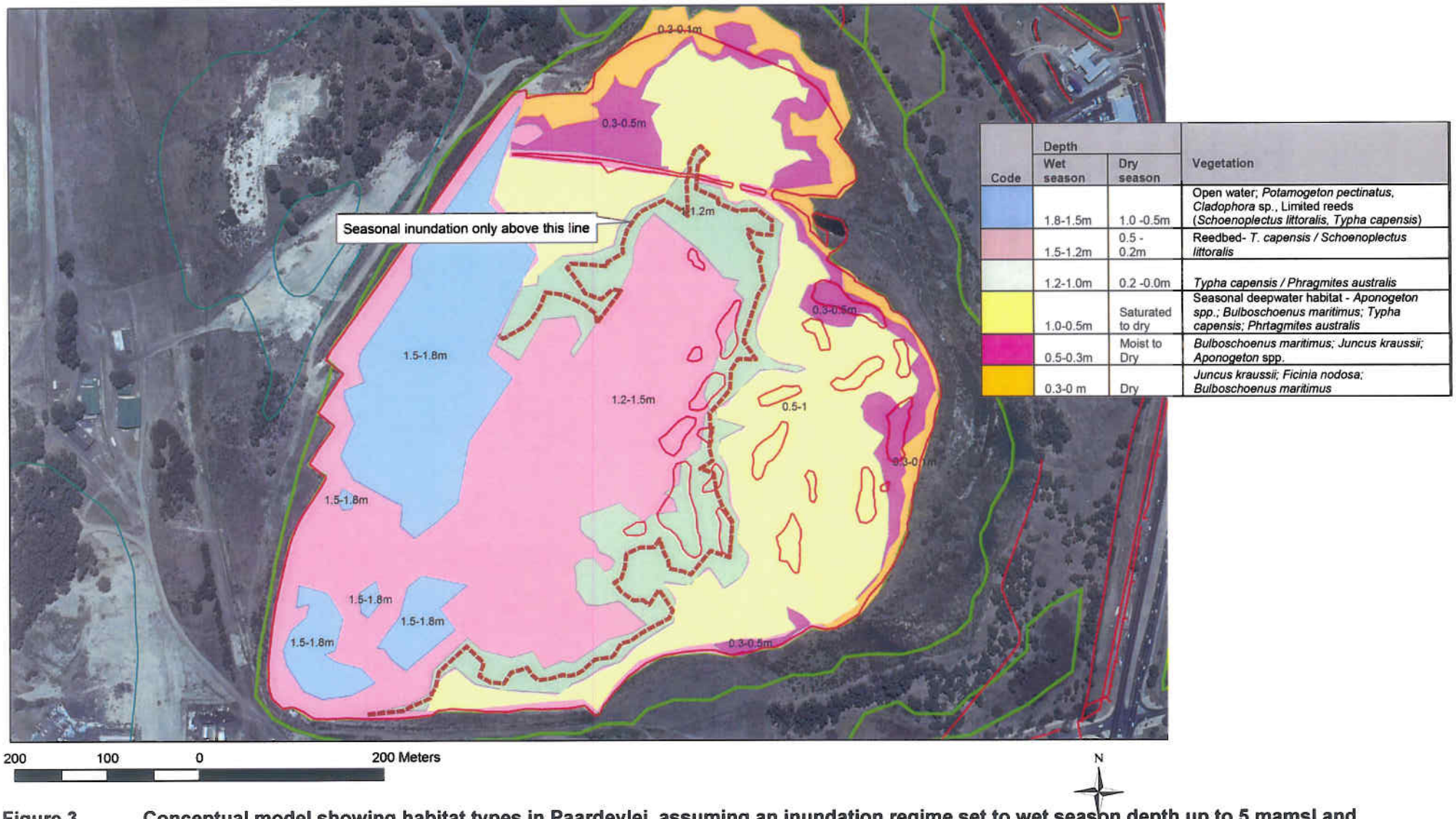

Figure 3 **Conceptual model showing habitat types in Paardevlei, assuming an inundation regime set to wet season depth up to 5 mamsl and dry season draw-down and evaporation to 4mamsl. Depths shown in each coloured zone in figure comprise maximum (wet season) depth in zone.**

3.3 Water quality specifications

Day (2009) identified poor water quality as one of the most significant risks to the long-term sustainability of Paardevlei as an aesthetically attractive wetland with high habitat value. In particular, nutrient enrichment and low salinities were identified as most likely to contribute to a long-term deterioration in wetland quality, with the former likely to promote algal blooms and plant invasion and the latter likely to encourage the establishment of *Typha capensis* in shallowly inundated to saturated areas of the vlei, at the expense of the (still invasive but aesthetically and ecologically preferred) *Phragmites australis* and *Bulboschoenus maritimus* reeds and sedges.

Given the challenges of addressing poor water quality issues, Table 1 (after Day 2009) provides "ideal" water quality specifications that ought to be striven for, in an annotated framework from which the implications of deviations from these specifications can be gauged. On the basis of this table, a more achievable set of management criteria has also been formulated with regard to water quality. However, it is stressed that, coupled with this downgrading of water quality standards, inevitably comes an increase in the risk of incurring substantial water body degradation over time, and these specifications should thus be viewed as minimum criteria.

Parameter	Measurement	Desired management objective	Realistic management range	Consequences of deviation from desired range	Critical limit – beyond which severe impairment will take place	Confidence in accuracy of predictions
				problems may all occur. (DWAF 1996b) DWAF (1996c) notes that for Chl-*a* > 10 *ug*/L, water begins to be distinctly "murky" in appearance		
Blue-green algae (Cyanophyta)	Blue-green units	< 6		Neither full nor intermediate contact recreation are permitted at higher concentrations (DWAF 1996b)		Medium
Electrical conductivity (EC)	mS/m	450-800	< 100	The desired management EC range lies within the expected natural range for this vlei but more importantly has been recommended as a range in which dominance by *Typha capensis* would be unlikely and which would encourage the growth of *Schoenoplectus littoralis*, *Phragmites australis* and *Bulboschoenus maritimus*. The low EC range achievable by the use of the available water sources for the vlei would facilitate expansion of *Typha capensis* into all permanently saturated to shallowly inundated areas	> 1000: saline	Medium
pH	pH units	6.5-7.5	7.5 -8.5	At higher pH levels, aquatic ecosystems are more vulnerable to impacts such as ammonia toxicity which increases at these pH levels	8.5: toxicity increases dramatically	High
Escherichia coli bacteria	Counts / 100ml	0		*E. coli* and other faecal bacteria in large numbers have implications for human health (contact recreation is not permitted at counts > 200 / 100ml associated with risk of gastro-intestinal disease); in addition, the presence of these bacteria also indicates the presence of organic pollutants, usually associated with phosphorus and ammonia loading	> 130	Medium
Faecal coliform bacteria	Counts / 100ml	0			> 130	Medium
Oxygen	Saturation (%)	80-120%	> 60%	At reduced oxygen concentrations, biota may experience stress and be vulnerable to other impacts (e.g. ammonia toxicity, fungal infection)	<40 %: lethal	Medium
Dissolved Fluoride	mg/l	< 0.750	<1.5	Dissolved fluoride at concentrations >1.5 mg/l would be associated with chronic effects on aquatic ecosystems	>2.54: acute toxicity	Medium

3.4 Landscaping specifications for Paardevlei

The landscaping design for Paardevlei and its immediate open space precincts has focused on achieving the ecological specifications outlined in Section 3.2, while ensuring that the available recreational and aesthetic opportunities potentially presented by Paardevlei can be harnessed, within the constraints of the selected design. The following landscaping specifications have been developed by CNdeV (as outlined in Bau-Afrika et al 2010):

- Islands and marginal areas of the wetland should be shaped so as to maximise their contribution to habitat quality and, in the case of marginal areas, to maximise their ability to contribute a protective function in buffering the wetlands from adjacent impacts;
- Planting of these areas should be carried out in a phased manner, with a view to establishing quality wetland and terrestrial habitats across the Paardevlei wetland and surrounding open space and conservation areas, in keeping with the ecological vision for the vlei and its margins; planting must include locally indigenous species only, and long-term removal of alien vegetation is required;
- Paths, boardwalks and stepping stones should be constructed, to allow access to bird hides, jetties and look-out points – it is noted that construction of these would however be subject to authorisation by DEADP, through a Basic Assessment and/or Environmental Impact Assessment process;
- Interest in the wetland should be stimulated as far as possible, through the provision of pathways, informative signage and other measures that will encourage appropriate use and appreciation of the vlei and its open space precincts.

Figure 4 (after Bau-Afrika *et al.* 2010) provides a conceptual landscape design for the vlei, as developed at the time of preparation of this document.

3.5 Engineering specifications

3.5.1 Water supply

Paardevlei may be supplied with water from any of the following sources (after Bau-Afrika et al (2010):

- Direct precipitation onto the vlei;
- Inflows of stormwater from the Crescent Bypass;
- Annual draw-off from the Lourens river via the Melck Sloot;
- Stormwater generated in the external catchments drained by the Helderview and the Schonenberg channels (Figure 2);
- Stormwater generated on areas of the Heartlands site that are developed in the future.

3.5.2 Inundation regime

The recommended inundation regime for Paardevlei requires that water levels in the planned seasonally inundated wetland margins should be drawn-down annually so as to allow **at least 4 months of dryness** in these habitats, and preferably longer. Such seasonal drawdown periods are intended to:

- Facilitate establishment of seasonally inundated wetland habitat;
- Discourage the invasion of these marginal areas by *Typha capensis*, the establishment of which is limited in areas subject to seasonal heat and water stress.

In order to achieve the seasonal range in water levels recommended by Day (2009), the engineering and landscaping designs were based on an upper wet season level set at 5mamsl, formally drawn down to a level of 4.3mamsl, with the assumption that high summer evaporative losses would result in drawdown of the vlei to a level of 4mamsl or lower.

3.5.3 Design of a draw-down system

In order to achieve the recommended inundation regime, a variable outlet system has been constructed at the outlet of Paardevlei, as shown in Photo 1. This system has been designed

Table 1 **Ideal (desired) and minimum management objectives for key water quality variables in Paardevlei. Table adapted from Day (2009)**

Parameter	Measurement	Desired management objective	Realistic management range	Consequences of deviation from desired range	Critical limit – beyond which severe impairment will take place	Confidence in accuracy of predictions
TSS / turbidity	Secchi depth (m)	4m	> 2.5m	Increasing turbidity will limit the extent to which *Potamogeton pectinatus* can establish in deepwater areas; failure to establish rooted macrophytes here will increase the likelihood of algal dominance; reduce habitat quality and thus increase the likelihood of pest populations of midges or other wetland associated species	<2 m	Low
Phosphorus	SRP (mg P/L)	< 0.02	< 0.05	Maintenance of in-lake phosphorus concentrations at phosphorus below 0.05 mg P/l would place Paardevlei at the threshold of eutrophication in terms of phosphorus, using criteria specified by DWAF (2002). As such, the water body would be highly productive, and without the rapid establishment of rooted macrophytes (e.g. reeds, sedges and pondweed), the water body could quickly be dominated by algal blooms. In any event, periodic algal blooms should be anticipated, particularly in spring and early summer – both floating algae and filamentous algae such as *Cladophora* sp. should be expected. Increased dissolved phosphorus concentrations would make the system more prone to invasion by floating plants including water hyacinth, *Azolla filiculoides* and *Lemna gibba* and would also be likely to make management of reedbeds and other plants more intensive, and to increase the rate of accumulation of organic sediments, themselves often resulting in internal phosphorus loading (Cooke et al. 2005)	0.13: hypertrophic threshold	Medium to high
Total Inorganic Nitrogen	TIN (mg N/L)	< 0.5	1.0 - 0.5	Achieving the desired management range would place the water body in an oligotrophic state with regard to nitrogen nutrients. This conforms to the condition of many of the water bodies assessed in Section 5. Since some cyanobacteria (e.g. *Anabaena* sp.) are able to convert nitrogen from nitrogen gas in air to ammonium nitrogen, availability of this nutrient does not necessarily limit growth of these species.	2.5: eutrophic threshold	Medium to low

Parameter	Measurement	Desired management objective	Realistic management range	Consequences of deviation from desired range	Critical limit – beyond which severe impairment will take place	Confidence in accuracy of predictions
				Nitrogen nutrients are however likely to be taken up relatively efficiently by wetland plants, and reedbeds in particular (Kadlec and Knight 1998).		
Un-ionised ammonia	(NH_3-N) mg N/l	< 0.007	< 0.015	This value is the chronic effect value for unionized ammonia (DWAF 1996). At these elevated concentrations, impacts on fish fecundity may be observed. Of more concern is the fact that the higher accepted in-lake concentrations of this variable are, the more vulnerable the system becomes to acute toxicity episodes, as its normal range approaches toxicity thresholds. Activities that might result in increased levels of total ammonia in a system include the presence of nitrogen fixing organisms (e.g. *Anabaena*) as well as pollutants such as sewage. Factors that might increase the toxicity of an existing total ammonia concentration include increased temperatures increased pH (e.g. resulting from high photosynthesis). Acute ammonia toxicity often results in rapid fish deaths and deaths of other aquatic organisms. It has occurred in several of the case studies described in Section 5.	0.1: acute toxicity	Medium
Chlorophyll-*a*	µg/L	< 4	15	Data presented by Cooke *et al.* (2005) for North American systems suggest that high algal production rates may be self-sustaining, by contributing to turbidity, thus reducing light for rooted macrophytes and, through decomposition, potentially contributing through anoxic conditions to the release of phosphorus from bottom sediments. The desired management objective for Chlorophyll-*a* concentrations would be those indicative of an oligo-mesotrophic state in North American wetlands (Cooke *et al.* 2005). Increases above this concentration would be associated with increased turbidity (a factor already increased by wind action on inorganic fines), and an increased likelihood of algal dominance. At higher chl-*a* concentrations (10-20) algal scums are likely; at concentrations of 20-30 ug/L, nuisance blooms may occur; these may be accompanied by oxygen depletion and fish kills; at concentrations > 30, nuisance scums, fish deaths and odour		Medium

such that it allows (after Bau-Afrika *et al.* 2010):

- Optimum attenuation of post development flow and accommodates a 1:50 year peak to a maximum level 6.0 mamsl;
- A seasonal fluctuation in water levels (5.0 mamsl in winter – 4.3 mamsl in summer) as per the ecological specifications.

Photo A: Adjustable off-take system at the Paardevlei outlet

3.6 Links to downstream systems.

The Paardevlei outlet structure conveys water into an open channel, that links with the Main Drain, and hence to the Lourens River via a portion of the Wagenfeldt Wetlands. Long-term proposals for the outlet channel between the vlei and the Main Drain include recommendations that the channel should be landscaped and widened so as to function as a broad ecological corridor, and thus reinforce the ecological value of Paardevlei and other wetlands on the Heartlands site, particularly in the context of increasing development of the area.

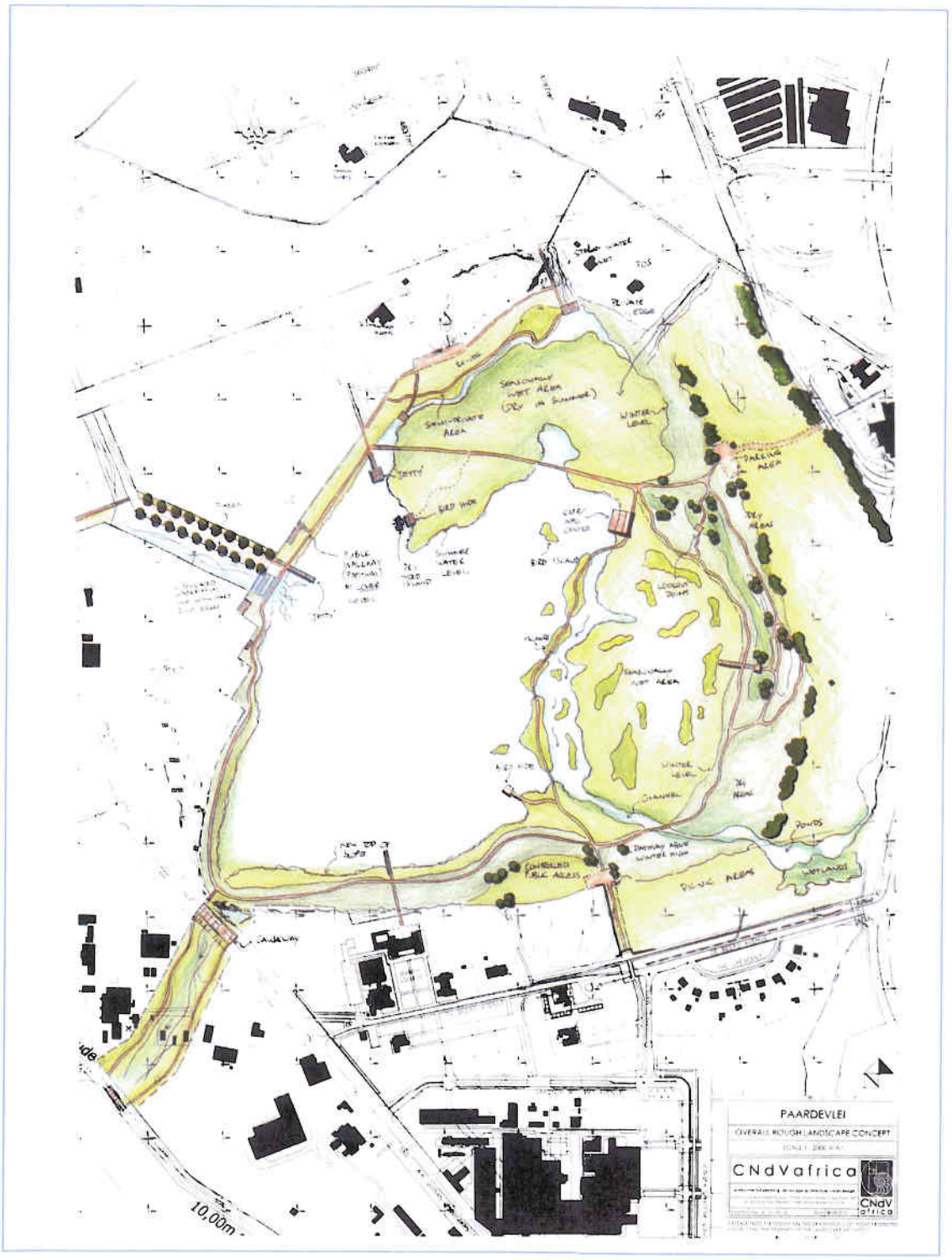

Figure 4 **Rough concept plan for Paardevlei, after Bau-Afrika et al. (2010). Concept plan produced by CNdeV.**

4 MANAGEMENT STRATEGY

4.1 Formulation of overarching management goals

This document is based on the premise that the long- term management goals for Paardevlei are that it should provide an **aesthetically attractive feature** in an **urban context**, while contributing in an **ecologically meaningful** and **sustainable** way to the provision of wetland habitat of a quality and type that is of **conservation significance**, and which provides both **educational** and **recreational opportunities** for its appreciation by local communities and visitors.

Acceptance of the above management goals implies a recognition that the Paardevlei wetland body will have a primary role as a wetland habitat of conservation importance, and that achieving appropriate levels of biodiversity within the system, and by virtue of its connectivity to other systems, should be an underlying thread in management of the system. At the same time, it is also recognized that the above will only be achievable if value can be added to human communities, through the harnessing of recreational and other opportunities associated with the wetland, as well as to adjacent property value, through the creation of an aesthetically pleasing wetland environment. Its urban context means moreover that the wetland will need to provide a variety of so-called ecosystem services to its urban community, in the form of flood attenuation and the amelioration of water quality in urban runoff.

The following sections outline a strategy for achieving the above over-arching goals in the management of Paardevlei and its environs, through a number of specific **management objectives**. It is assumed that future development planning for the surrounding area will take cognizance of and support these objectives.

The management strategy has six major objectives, which need to be successfully managed in order to achieve the over-arching management goals. Criteria for **target conditions** have been provided for each objective, in order to guide the management team in evaluation of the extent to which additional effort needs to be exerted in particular areas. A number of management **tactics,** comprising different suites of **activities**, have also been identified as appropriate tools for achieving target conditions. While the array of activities used to achieve target conditions and hence the associated management objectives may be adapted over time as additional management options and opportunities become available, the target conditions and management objectives themselves should not be amended, without serious consideration of the potential implications of change.

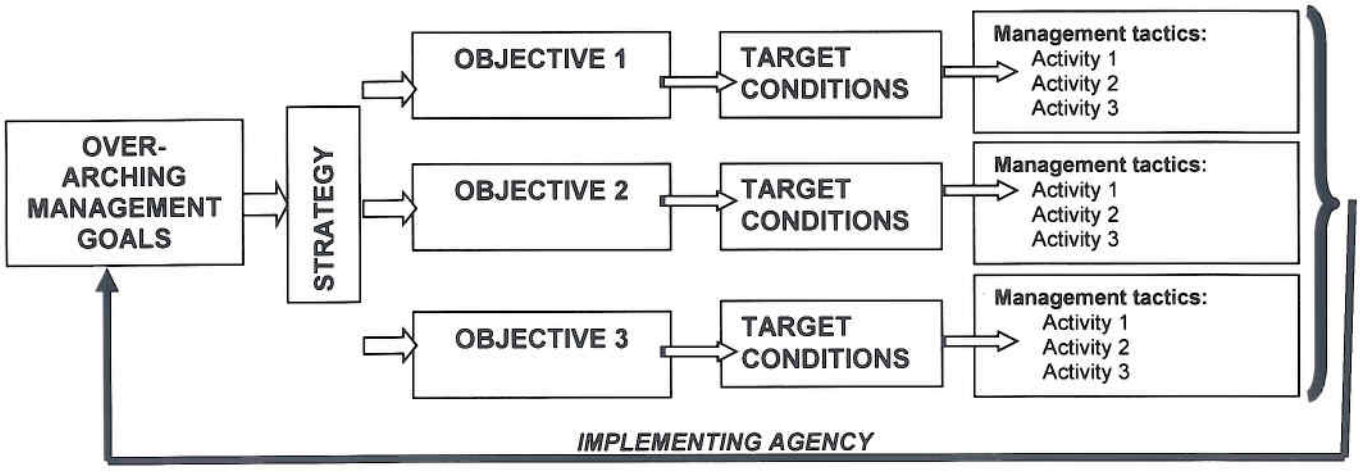

Figure 4 **Schematic showing interaction of component parts of the management plan in meeting the overarching wetland management goals**

4.2 Outline of Management Strategy

In order to meet the over-arching management goals for Paardevlei in the long term, the following seven high-level management objectives have been distilled:

- Objective 1: Establish an effective management team, with sufficient funds, personnel and expertise at its disposal to facilitate the long-term implementation of the Paardevlei Wetland Management Plan;
- Objective 2 Ensure that water quality is controlled so as to achieve at least minimum water quality thresholds;
- Objective 3 Control wetland and terrestrial physical habitat, plant community structure, extent and function, so as to maximise biodiversity, maintain an aesthetically pleasing but natural wetland appearance, and minimise negative impacts to adjacent land-owners, within the constraints posed by the designed hydrological wetland regime;
- Objective 4 Implement the hydrological regime implicit in the design of the vlei, including allowance for annual draw-down of water levels at the start of the dry season, and facilitation of inundation at the start of the wet season;
- Objective 5 Manage the extent and impacts resulting from recreational and other use of the vlei by humans such that the considerable educational and recreational opportunities afforded by the wetland are effectively and productively harnessed, without compromising the biodiversity and conservation requirements of the wetland management objectives;
- Objective 6 Manage perceptions in the local communities and the broader user group of the Paardevlei precincts such that the long-term management vision of the vlei as a natural seasonal wetland with conservation, aesthetic, educational and recreational value remains entrenched, and is not biased over time towards one or other user group;
- Objective 7 Implement an effective monitoring system, which allows the trajectory of the wetland in terms of meeting its ecological, hydrological, recreational, educational and aesthetic objectives to be monitored.

The above management objectives are described in the following sections, along with the rationale under-pinning each of them. Broad targets have also been outlined for each, with a view to guiding ongoing management activities, the major thrusts of which are highlighted for each management objective.

The actual management activities, in terms of the nature and frequency of each intervention / activity, are outlined in more detail in Section 5, which should be seen as the implementation task list of the Paardevlei Management Team.

4.3 Timeframes of the Management Strategy

The management strategy was compiled at an early phase of development of the overall Heartlands site, and is 'thus subject to ongoing review, to ensure that it remains focused on issues of relevance to vlei management in the future. The present document refers to short, medium and long-term objectives and activities, with lower levels of detail or certainty usually being attached to those recommended for implementation in the medium and long term.

As a guideline, "short-term" activities / objectives are those that must be considered with immediate effect, and should be implemented until at least the first review phase of this document (January 2017, five years after commencement of the operational phase of the wetland), unless specifically adapted or revised as a result of recommendations emanating from quarterly or annual environmental monitoring reports.

So-called medium and long-term activities and objectives are, in many cases, those that are most likely to be relevant or necessary only in the future, either as a result of maturation of the wetland (e.g. once reeds have established in the vlei, or when sediment accumulates in greater quantities than at present) or as a result of changes in landuse on the site (e.g. when recreational users need to be considered, and construction and management of bird hides, boardwalks, stormwater runoff and litter, for example, become relevant).

It is recognized moreover that there may also be a transitional phase in the operational management of the wetland, with phased development of surrounding areas resulting in a prolonged period when construction is taking place, but when some portions of the

development are established and becoming entrenched in their patterns of use of the surrounding area, while still other areas remain as-yet undeveloped. Regular review of the OEMP will thus be required in the future, to ensure that the implications for Paardevlei of these kinds of issues are adequately addressed.

Objective 1: ***Establish an effective management team, with sufficient funds, personnel and expertise at its disposal to facilitate the long-term implementation of the Paardevlei Wetland Management Plan***

Rationale:

A crucial component of effective long–term management of Paardevlei and its immediate precincts is the implementing agency or management team. It is essential that the management team is adequately resourced and sufficiently informed as to the management objectives and associated management strategy, for responsible prioritisation of management intervention activities to take place, and for the implications of decisions around land-use and other uses to be fully understood.

Target:

Establishment of a management team, with adequate funding and access to personnel to carry out the required management activities.

[1]*Overview of enabling management activities:*

The management team must:

- Have access to sufficient funding to carry out the required tasks in the short, medium and long term;
- Have a mandate to implement the management programme, including *ad hoc* or emergency responses to conditions that are likely to impact on wetland condition;
- Allow for liaison with personnel with specialist knowledge in the following areas: wetland function, water quality, avian behaviour and population dynamics, botany and plant management and stormwater engineering - input from the above may be required on an infrequent basis only;
- Be routinely on site, so that day-to-day changes in wetland function or condition can be identified and addressed timeously;
- Co-ordinate monitoring and maintenance activities involving Paardevlei and its environs and facilitate active communication with local and other interested communities regarding the condition and functioning of Paardevlei and its adjacent natural habitats.

Objective 2 ***Ensure that water quality is controlled so as to achieve at least minimum water quality thresholds***

Rationale:
Water quality is probably the most important determinand of the long-term structure, function and contribution (positive or negative) of the wetland to the surrounding development. The quality of water in the vlei will determine:

- the kinds of plants that grow in the vlei;
- the rate of plant growth;
- the intensity of ongoing plant maintenance activities;
- the aesthetic quality of the wetland;
- the suitability of the wetland for recreational activities such as rowing;
- the value of the wetland to surrounding land users – water quality resulting in bad odours, for example, would detract from the value of adjacent properties;
- the biodiversity value of the wetland;
- the integrity of natural ecosystems downstream.

Target:
The minimum water quality targets outlined in Table 2 (Section 3) should be achieved, and the "ideal" targets should be striven for in the long-term.

[1]*Overview of enabling management activities:*
Water quality management activities must include:

- stringent control over the quality of point-source inflows into the wetland – upstream pre-treatment, particularly in the form of oil and grease separation, litter control and inorganic sediment removal and nutrient reduction should take place, such that the full onus of water quality treatment of runoff does not accrue to the Paardevlei reedbeds;
- landscaping of the areas in the vicinity of the vlei should be based on indigenous vegetation, and the use of fertilisers, manures and other nutrient-enriched material is not advisable;
- active management of wetland vegetation so as to contribute to water quality management;
- support for the annual draw-down of water levels in the vlei from a water quality perspective, as it facilitates flushing of surface waters;
- provision for long-term periodic dredging of portions or the vlei, in areas where organic sediments accumulate;
- control over the number of artificial heronries / nesting areas in the wetland, given that birds will contribute to long-term nutrient enrichment; these point sources of pollution should be managed to minimise their contribution to broader nutrient enrichment;
- assessment / auditing of all activities in the vicinity of the vlei in terms of their impacts on wetland water quality, and management of these so as to minimise impact.

Objective 3 Control wetland and terrestrial physical habitat, plant community structure, extent and function, so as to maximise biodiversity, maintain an aesthetically pleasing but natural wetland appearance, and minimise negative impacts to adjacent land-owners, within the constraints posed by the designed hydrological wetland regime.

Rationale:

The kinds of plants that are established or establish themselves on and adjacent to Paardevlei, their extent and rate of growth and die-back are all critical components that:

- determine the suitability of the wetland and its environs for wetland –associated fauna (and thus play a feed-back role in controlling biodiversity);
- determine the intensity of management interventions required in the vlei;
- directly affect the aesthetic qualities of the wetland;
- can affect water quality through the uptake or release of nutrients, or the trapping of sediment and other substance contained in runoff into the wetland.

Note that the kinds of plants, and the rate of plant growth in the wetland and its environs will in turn be determined largely by water quality and the hydrological regime of the vlei.

Target:

The long-term Paardevlei should comprise a seasonally inundated system, with maximum habitat diversity, recognising that the system created will however naturally be dominated by reedbeds, which have an important role to play in terms of habitat and water quality. Effective ecological linkages between Paardevlei and adjacent conserved areas and / or important habitats on the broader Heartlands site must be established and maintained through management of vegetation type and structure.

Overview of management activities:

- Invasion of wetland areas by *Typha capensis* must be strictly controlled over the rehabilitation implementation period – that is, for at least one year after completion of planting of all wetland marginal areas shallower than 4 mamsl (see Figure 3 for indication of this line);
- The rehabilitated Paardevlei must include a wide range of wetland habitat types, including deep open water habitat, extensive reedbed areas, shallow seasonally inundated sedge habitat, seasonally inundated deepwater flats, isolated seasonally inundated wetland depressions beyond the main vlei margins, and terrestrial areas, that provide ecological corridors linking wetland habitats, as well as acting as ecological buffer areas;
- Wetland habitat within Paardevlei and its margins, up to and including its ecological buffer areas, should support locally indigenous floral and faunal species only and alien species must be excluded by active management;
- Management of potentially problematic locally indigenous species (e.g. *Cladophora* spp. or *Typha capensis*), where the presence of the plant may result in long-term conflict with human communities, must be undertaken on a species by species basis, and with a view to minimising human inconvenience, without jeopardising wetland structure and function and taking cognisance of the fact that Paardevlei is intended to be managed and utilised as a natural ecosystem, and hence the presence of natural faunal and floral communities is to be expected, even where these may pose as irritants to human users.

Objective 4 Implement the hydrological regime implicit in the design of the vlei, including allowance for annual draw-down of water levels at the start of the dry season, and facilitation of inundation at the start of the wet season.

Rationale:

An integral part of the long-term management vision for Paardevlei is its hydrological regime, which revolves around summer draw-down and wet season inundation. The motivation for this regime has been explored thoroughly in Day (2009) and has been touched upon in Section 3 of this report. The wetland type likely to be supported by such a regime is considered to be most robust in the face of changing water quality and uncertain water supply. It is also most cost-effective in terms of long-term management. Thus, while the recommended hydro-regime brings with it constraints on certain recreational uses of the vlei (e.g. most boating activities) and carries with it a specific aesthetic quality (reedbed wetland rather than open water lake), it is a critical aspect of the long-term wetland management strategy.

Target:

The hydrological regime specified in Section 3.5 must be implemented and monitoring undertaken to allow tweaking of the system if necessary, to achieve the stated ecological targets.

Overview of enabling management activities:

- During the wet season, vlei levels must be set to a maximum level of 5 mamsl, with short term flood attenuation to 6 mamsl;
- A manual draw-down of water levels must be implemented no later than 30 September of each year, to a maximum level of 4.3 mamsl;
- Additional loss of vlei water levels to 4mamsl or lower is required during summer, and would be facilitated by evaporation and (limited) irrigation abstraction;
- A period of at least four months is required during summer / autumn when the vlei margins (yellow, purple and orange areas in Figure 3) are dry, to limit invasion by *Typha capensis*.

Objective 5 ***Manage the extent and impacts resulting from recreational and other use of the vlei by humans such that the considerable educational and recreational opportunities afforded by the wetland are effectively and productively harnessed, without compromising the biodiversity and conservation requirements of the wetland management objectives***

Rationale

The long-term sustainability of the ecological, aesthetic, recreational and educational attributes of Paardevlei will be dependent on the level to which ongoing wetland management is able to strike a balance between potentially conflicting or competing demands by different user groups. Since the benefit derived by human users is directly dependent on the integrity of the natural ecosystem, it follows that the former should be controlled such that it does not compromise the system on which it depends; at the same time, it is also recognised that unless the benefits associated with management of a natural system in close proximity to urban developments are tangible, the required level of ongoing management input into the system is likely to falter over time, affecting ecological sustainability as well as recreational and other benefits.

Target:

The vlei should be seen as a valuable conservation and recreational asset.

Overview of enabling management activities:

- Recreational activities in the vlei must be controlled from the start, given the likely long-term dominance of the vlei by aquatic weeds, reedbed and sedge marsh, which will all limit activities such as sailing, wind surfing, fishing and skiing in the future. Given this, such uses must not be allowed to become established in the vlei, as this will create usage precedents in conflict with the management requirements of the wetland (draw-down; reedbed dominance etc);
- Limited opportunities exist for canoeing in managed areas and reedbed management should include provision for ongoing clearing / cutting of swathes of vegetation through demarcated areas of the wetland to facilitate canoeing if this activity is desired;
- The provision of jetties, boardwalks and bird hides in the vlei should be supported, as a means of allowing active engagement of local communities with the Paardevlei wetland ecosystems – such infrastructure must however be designed so that it does not result in significant disturbance of wetland flora and fauna and does not detract from the aesthetic and ecological value of the wetland as a whole – the design and construction of such infrastructure would need authorisation in terms of both NEMA and the NWA;
- Artificial stocking of alien fish into the vlei must not take place, and recreational fishing should not be allowed, as this would in turn encourage stocking to take place;
- Allowance must be made for ongoing management of litter;
- Management of plants that are considered aesthetically problematic should be allowed for on a localised level only, bearing in mind that the overall vision of the vlei is for a largely natural system; management of *Cladophora* algae and *Typha capensis* is possible within the vicinity of the "urban" edge of the vlei, but is neither realistic nor desirable at a larger scale. Note that specific plant management activities address short- and long-term management strategies for *Typha capensis*.

Objective 6 ***Manage perceptions in the local communities and the broader user group of the Paardevlei precincts such that the long-term management vision of the vlei as a natural seasonal wetland with conservation, aesthetic, educational and recreational value remains entrenched, and is not biased over time towards one or other user group.***

Rationale:
It is essential that the long-term vision for Paardevlei and its precincts, which is embedded in the design of the vlei, its outlet structures and its interface with adjacent user bodies, should be kept at the forefront of perceptions of the wetland, so that the significance of issues such as birdlife, the extent of reeds, the persistence of potentially nuisance but natural wetland fauna and flora, limitations on recreational activities such as water sports and the annual summer draw-down period are not re-interpreted in the future, in the absence of a full understanding of the objectives of wetland design and management.

Overview of enabling management activities:
Ongoing education and information programmes should inform users of the management history, present condition and future trajectory of the wetland, and of the implications of these for present and future users. Realities such as the likely presence of midges, mosquitoes, algae, birds, reedbeds, should be adequately described, and management approaches to these issues outlined.

Objective 7 ***Implement an effective monitoring system, which allows the trajectory of the wetland in terms of meeting its ecological, hydrological, recreational, educational and aesthetic objectives to be monitored***

Rationale: An important aspect of any management system is to provide the means of assessing the efficacy of management tactics, and the condition of the managed system. Through effective monitoring, the need for additional or alternative interventions can be identified timeously, thus (usually) reducing the costs of delayed remediation interventions.

Target:
Monitoring data must be adequate to allow clear-cut decision making around management activities.

Overview of enabling management activities:
A monitoring programme must be set up, which allows for the long-term collection, collation and interpretation of data relating to the following aspects of the vlei:

- Meteorological data (rainfall temperature etc)
- Hydrological data (seasonal water level fluctuations in the vlei)
- Sediment depth and quality
- Water quality data for inflowing and in-lake conditions
- Presence of and extent of invasive alien and indigenous vegetation
- Fish population structure and size
- Bird population structure, size and seasonal change
- Seasonal and spatial changes in bird activities
- Visitor numbers and comments
- Perceptions of local landowners.

5 MANAGEMENT ACTIVITIES

The seven Management Objectives outlined in the previous section have been unpacked in more detail in this present section, which provides a range of tabulated management tools and/or activities that should inform day-to-day management activities in the vicinity of Paardevlei.

These recommendations have been developed iteratively in consultation with the Heartlands project team, CNdeV landscape architects and Bau-Afrika stormwater engineers, and have responded to early comment by Ms Natalie Newman of the City of Cape Town's E&HM Branch (District E).

MANAGEMENT OBJECTIVE 1:

Establish an effective management team, with sufficient funds, personnel and expertise at its disposal to facilitate the long-term implementation of the Paardevlei wetland management plan

Measurable criteria:	**Effective long-term implementation of the management plan and sustainable management of the vlei and its open space / conservation precincts**

MANAGEMENT TACTIC	ACTIVITY	RISK OF INADEQUATE ACTION	FREQUENCY OF INTERVENTION	RESPONSIBILITY
A. Secure adequate long-term funding for management activities	1. Consider short, medium and long-term rehabilitation, landscaping and maintenance requirements for the vlei and its open space environs and carry out detailed costing for envisaged activities. In the short term (assumed to be the first five years) funding will be provided by the Paardevlei Umbrella Association, which in turn obtains funding via levies from individual precincts. Once Heartland Property moves into the development phase of the precincts surrounding the Paardevlei (i.e. in the medium to long term development phases), a funding agreement must be drawn up as part of the Property Owners' Association (POA) for the greater Heartlands development, to ensure sustainable wetland management 2. Identify the likelihood and frequency of additional management requirements and set aside / allow for access to additional ad hoc funds when necessary 3. Secure adequate funding on a sustained basis, that is not at the discretion of future home owners with different priorities	Inability to implement sustainable long-term management of the wetland	During planning and early rehabilitation phases	• Paardevlei Management team • stormwater engineer • landscape architect • wetland ecologist
B. Ensure that the over-arching management vision and goals for the vlei are achieved	1. Establish an effective management team, with sufficient financial and human resources to accomplish the required management activities; a. The management team should include or facilitate liaison with, personnel with specialist knowledge of hydrology, wetland function, water quality, botany, avian behaviour and population dynamics,	Inability to implement sustainable long-term management of the wetland	During planning and early rehabilitation phases and Ongoing	Paardevlei Management Team

MANAGEMENT TACTIC	ACTIVITY	RISK OF INADEQUATE ACTION	FREQUENCY OF INTERVENTION	RESPONSIBILITY
	as well as stormwater engineers - input from the above specialists is likely to be required on an *ad hoc* or infrequent basis only b. Core members of the management team must be routinely on site, so that day to day changes in wetland function or condition can be identified and addressed timeously 2. Ensure that the management team has a mandate to implement the management programme, including *ad hoc* or emergency responses to conditions that are likely to impact on wetland condition 3. Co-ordinate monitoring and maintenance activities involving Paardevlei and its environs and facilitate active communication with local and other interested communities regarding the condition and functioning of Paardevlei and its adjacent natural habitats 4. Audit the effective implementation of the Operational Phase Management Programme (OEMP) on an annual basis and ensure that the specified activities are being carried out at their recommended frequencies and timing 5. Review the OEMP on a three yearly basis, and make revisions to the timing, frequency or nature of recommended management and monitoring activities such that the OEMP continues to reflect best practice, updated as technology and management science improve, and modified to incorporate knowledge gained from actual management experience at Paardevlei. The review process should ensure that the OEMP is adapted to address changing ecological or management pressures, but that it still meets its over-arching management goals.		Annual Three yearly	Appointed independent assessor Appointed independent assessor

MANAGEMENT OBJECTIVE 2:

Ensure that water quality is controlled so as to achieve at least minimum water quality thresholds

Measurable criteria:	• Minimum target water quality standards (Table 3) should always be met • Target water quality objectives should be achieved in the long term

MANAGEMENT TACTIC	ACTIVITY	RISK OF INADEQUATE ACTION	FREQUENCY OF INTERVENTION	RESPONSIBILITY
A. Stringent control over the quality of point-source inflows into the wetland	**PLANNING AND DESIGN CONTROLS** 1. New stormwater outlets into Paardevlei, including minor outlets from adjacent landowners must all be fitted upstream of their outlets with litter and sediment traps 2. The design of all stormwater channels passing into Paardevlei should be such that opportunities for water quality amelioration are maximized throughout the conveyance stream 3. All parking areas and other areas within the Paardevlei catchment area that are likely to be associated with the production of hydrocarbon pollutants must be designed or fitted with appropriate devices that allow separation of contaminated runoff and its separate treatment / disposal **ONGOING ACTIVITIES** 4. All sediment and litter traps passing into the vlei must be routinely cleared and their function monitored 5. Problematic sediment and litter traps must prompt interventions aimed at addressing issues at source 6. Routine monitoring of stormwater outlets (visual inspection and water quality data) must strive to ensure that no runoff or seepage water contaminated with commercial, industrial or domestic waste (e.g. cooking or washing water; car washing water; swimming pool discharges) is passed into the stormwater system	Ongoing, incremental and unrectifiable pollution of Paardevlei Ongoing and incremental pollution of Paardevlei	1-3: Planning and approvals phases for new developments / structures 4. Monthly or as required 5. As required 6. Monthly and after / during runoff events	• Project engineer • Planning team • Paardevlei Management Team Paardevlei Management Team
B. Implement landscaping / planting controls	**PLANNING AND DESIGN CONTROLS** 1. Landscaping of the areas in the vicinity of the vlei (i.e. within the designated vlei buffers and, ideally, within a	Plants with higher requirements for	Planning and approvals phases	Project landscaper Paardevlei

MANAGEMENT TACTIC	ACTIVITY	RISK OF INADEQUATE ACTION	FREQUENCY OF INTERVENTION	RESPONSIBILITY
	zone of 100m from the edge of the wetland as shown in Figure 3) must be based on planting of locally indigenous vegetation only	irrigation and fertilising will be established, resulting in a need for fertiliser etc	for new developments / landscaped areas	Management Team
	ONGOING ACTIVITIES 2. Fertilisers, manures and other nutrient-enriched material may not be used in areas abutting the vlei or its adjacent wetlands and planting in these areas must rely on the selection of appropriate plants, adapted to low-nutrient conditions, and the use of mulches and low-nutrient composts 3. Nutrient-enriched irrigation water (e.g. treated sewage effluent) may not be used for the irrigation of any areas within 50m of Paardevlei	Ongoing nutrient enrichment of Paardevlei	Ongoing inspections	Paardevlei Management Team
C. Support for annual (summer) draw-down of vlei levels	1. The annual draw-down of water levels must take place as per recommendations for Objective 4 2. Any abstraction of irrigation water should preferably take place from areas likely to be most nutrient-enriched and subject to lowest levels of flushing – e.g. areas adjacent to bird nesting platforms and in deep water pools adjacent to the western edge 3. Onset of the wet season inundation period should be delayed until at least one late autumn "flush" has passed through the vlei, providing an opportunity for flushing of poor water quality accumulated in the wetland over summer	Ongoing nutrient enrichment of Paardevlei	1. Annually: 30 September 2. Summer 3. Annually: April /May	Paardevlei Management Team
D. Periodic dredging of sediments	1. Provision must be made for periodic dredging of portions of the vlei most prone to build-up of inorganic (derived from the Paardevlei catchment) and organic (largely derived from in-lake production of plant material) sediments: a. Disposal of sediment may only be to an approved location, where it will not impact on any conservation	Pollution of Paardevlei as a result of internal cycling of nutrients between sediments and the water column, exacerbated by wind	Infrequently (estimated frequency >10 years) – when water and sediment quality	Paardevlei Management Team

MANAGEMENT TACTIC	ACTIVITY	RISK OF INADEQUATE ACTION	FREQUENCY OF INTERVENTION	RESPONSIBILITY
	areas b. Dewatering of sediment in areas abutting the vlei may be necessary prior to disposal <u>Note:</u> Dredging of sediment from a wetland could require environmental authorization	action	data, and sediment depths, suggest intervention is necessary	
E. Control of birds	1. The number of artificial nesting areas (i.e. heronries) introduced to the vlei must be controlled – no more than three should be installed initially, and this number should be revised up or downwards contingent on medium to long term water quality issues 2. All heronries must be designed with features that allow the removal of guano from nesting platforms so as to minimize water quality impacts to Paardevlei 3. The number of terrestrial grazing birds (e.g. Egyptian Geese), which are likely to import nutrients into the vlei from elsewhere should ideally be controlled – limiting large lawned areas abutting the vlei is one way to achieve this	Ongoing nutrient enrichment	Ongoing	• Paardevlei Management Team • Avifaunal specialist • Water quality specialist
F. Control of cattle	*1.* Cattle may not graze in the wetland or its buffer areas – they import nutrients into the wetlands and furthermore trample vegetation and spread alien seed material	Nutrient enrichment and wetland degradation	Ongoing	Paardevlei Management Team
G. Implement a Water and Sediment Quality Monitoring programme	1. The **water quality monitoring programme** must incorporate the following elements: a. Its design, implementation and interpretation must be informed by a water quality specialist b. Selection of fixed long term monitoring sites that allow for: i. Monitoring of all point source inflows into the vlei to identify problematic source areas ii. Monitoring of selected points in the vlei (upstream, near outlet, deepwater portions, shallow water seasonal portions) c. Collection and analysis of water from the above points	Failure to identify threats to water quality until major impacts realised	1a-b. Once-off at start of programme, revised periodically	• Paardevlei Management Team • Water quality specialist

MANAGEMENT TACTIC	ACTIVITY	RISK OF INADEQUATE ACTION	FREQUENCY OF INTERVENTION	RESPONSIBILITY
	for at least the following variables: i. *In situ* pH, EC, Temperature, Turbidity, DO and Fluoride ii. Laboratory analysis of major nutrients (NH4-N, NH3, NO3+NO2-N; PO4-P, Total Phosphorus and chlorophyll-a iii. Laboratory analysis of TSS iv. Laboratory analysis of *Escherichia coli* bacteria d. Production of (at least) quarterly monitoring reports red-flagging problem areas 2. The **sediment monitoring programme** must incorporate the following elements: a. Its design, implementation and interpretation should be informed by a water quality specialist b. Selection of fixed long term monitoring sites in areas prone to sedimentation and its impacts: these should include the deepwater area adjacent to the western edge and the area in the vicinity of the outlet weir c. Monitoring sites should be fitted with fixed measuring devices, against which depth from a fixed height to the vlei bed can be quickly and conveniently measured with a measuring rod d. Sediment depth should be measured at fixed sites e. Sediment should be collected for sampling by grab sampler or other appropriate device, and analysed at a laboratory for at least: i. Total phosphorus ii. Total organic carbon iii. Particle size fractions e. Production of (at least) three-yearly monitoring reports red-flagging problem areas and recommending remediation activities where necessary		1c: Monthly 1d: Quarterly 2a-c. Once-off at start of programme 2d: annual 2e: three yearly	

MANAGEMENT OBJECTIVE 3:

Control wetland and terrestrial physical habitat, plant community structure, extent and function, so as to maximise biodiversity, maintain an aesthetically pleasing but natural wetland appearance, and minimise negative impacts to adjacent land-owners, within the constraints posed by the designed hydrological wetland regime

Target criteria:	The long-term Paardevlei should comprise a seasonally inundated system, with maximum habitat diversity, recognising that the system created will however naturally be dominated by reedbeds, which have an important role to play in terms of habitat and water quality. Effective ecological linkages between Paardevlei and adjacent conserved areas and / or important habitats on the broader Heartlands Site must be established and maintained through management of vegetation type and structure.

MANAGEMENT TACTIC	ACTIVITY	RISK OF INADEQUATE ACTION	FREQUENCY OF INTERVENTION	RESPONSIBILITY
A. Control of alien terrestrial vegetation	1. A landscaper, botanist or other specialist must be approached to assist with training of staff in the identification of common alien and indigenous plants and the identification of new plant species as they are found	1. Accidental removal of desirable plants and establishment of problem species through miss-identification	1. Once-off training and on *ad hoc* basis thereafter	Botanist/ landscaper and Paardevlei Management Team
	2. Terrestrial alien plants must be removed on an ongoing basis on sight. The following species are already considered problematic in the Paardevlei environs: • *Acacia saligna*: these must be pulled as seedlings or cut and the stumps sprayed with [1]approved herbicides • *Eucalyptus*: All seedling and sapling *Eucalyptus* must be cut or pulled on sight; Adults selected for retention should be marked by the landscaper [the long term plan for this species is its removal from all conservation areas, although it may be retained in non-conservation areas] • *Pennisetum clandestinum* (kikuyu grass): to be pulled and/or hand sprayed with approved herbicide; • *Cortaderia spp.* (pampas grass) to be dug out on	2. Loss of biodiversity; Increasing seedbank and on-site proliferation of problem plants;	2. On sight and during monthly inspections of open space areas	Botanist/ landscaper and Paardevlei Management Team

[1] Any herbicide used must be approved as suitable for use near wetlands / water courses / bird and frog habitat and sprayed only in accordance with instructions from qualified herbicide applicator

MANAGEMENT TACTIC	ACTIVITY	RISK OF INADEQUATE ACTION	FREQUENCY OF INTERVENTION	RESPONSIBILITY
	sight; • *Arundo donax* (Spanish reed): to be dug out on sight (machinery or spade); • Nasturtium (*Tropaeolum* sp.) to be hand pulled on sight; 3. Removed plants to be disposed of such that they do not spread to other areas of conservation concern	3. Loss of biodiversity; Increasing seedbank and on-site proliferation of problem plants;	3. Ongoing	Botanist/ landscaper and Paardevlei Management Team
B. Control of alien aquatic vegetation	1. A landscaper, botanist or other specialist must be approached to assist with training of staff in the identification of common alien and indigenous aquatic plants and the identification of new plant species as they are found 2. Alien aquatic plants must be removed on an ongoing basis on sight. The following species could become problematic at some stage in the vlei's operational phase, although only *Azolla filiculoides* was present at the time of writing: • *Azolla filiculioides:* may be removed by hand-netting from localized areas if considered problematic aesthetically; the only effective control is by biocontrol, using the *Stenopelmus* weevil; this species should colonise naturally within a few weeks of invasion and no management steps are required • *Eichhornia crassipes* (water hyacinth): **priority aquatic weed** to **remove by hand on sight** and apply to Alien Plant Control Unit at Rhodes University for *Neochetina eichhorniae* (biocontrol weevil) stock if hyacinth establishment becomes significant • *Commelina benghalensis:* **priority weed found in terrestrial and moist marginal areas: remove by hand on sight** – highly problematic weed that is very difficult to remove; spray with appropriate herbicide or bury (at least 50cm below surface) • *Pistia stratiotes* (water lettuce): **remove by hand on sight** • *Salvinia molesta* (Kariba weed): **priority weed:**	1. Accidental removal of desirable plants and establishment of problem species through mis-identification 2. Loss of biodiversity; increase in organic sediments on vlei bottom, contributing to anoxic conditions; loss of open water areas ;	1. Once-off training and on *ad hoc* basis thereafter 2. On sight and during monthly inspections of open space areas	Botanist/ landscaper and Paardevlei Management Team Botanist/ landscaper and Paardevlei Management Team

MANAGEMENT TACTIC	ACTIVITY	RISK OF INADEQUATE ACTION	FREQUENCY OF INTERVENTION	RESPONSIBILITY
	remove by hand on sight and apply for biocontrol • *Myriophyllum aquaticum* (parrot's feather): remove by hand on sight • *Rorippa nasturtium-aquaticum* (watercress): occurs in marginal shallow areas and spreads quickly – difficult to remove permanently, but remove at least 6 monthly by hand-pulling 3. Removed plants to be disposed of such that they do not spread to other areas of conservation concern	3. Loss of biodiversity; increasing seedbank and on-site proliferation of problem plants;	3. On sight and during monthly inspections of open space areas	Botanist/ landscaper and Paardevlei Management Team

Eichhornia crassipes

Pistia stratiotes

Rorippa nasturtium-aquaticum

Azolla filiculoides

Myriophyllum aquaticum

Commelina benghalensis

[PHOTOS TAKEN FROM WIKIPEDIA]

MANAGEMENT TACTIC	ACTIVITY	RISK OF INADEQUATE ACTION	FREQUENCY OF INTERVENTION	RESPONSIBILITY
C. Control of *Typha capensis* [**Note**: Freshening water quality in the vlei in the long term, with increasing stormwater inflows is likely to result in conditions that increasingly favour *Typha capensis* establishment, in the event that the species takers hold, long-term removal is not considered sustainable, and maintenance measures thus centre on nuisance reduction.]	**Short term measures** 1. *Typha capensis* must be hand-pulled from any new areas along the vlei margins in which it establishes itself until at least one year after completion of the rehabilitation implementation period (that is, complete planting of the vlei margins down to the 4masmsl mark) 2. Existing patches of the plant must be identified and its further spread from these areas controlled by manual (spade) removal of spreading rhizomes and by annual cutting back of plants using scythes or other to prevent seeding of mature plants 3. The proliferation of a range of other, densely growing wetland species in the vlei should reduce the extent of invasion by *T. capensis*, particularly if these plants are able to establish well in the absence of *T. capensis*. An adequate planting budget should be made available to enable establishment of significant areas of other, more desirable indigenous wetland plants in the short term of the operational phase of the project, to limit invasion opportunities for *Typha* **Long-term measures** 4. Maintenance of deep areas (see Figure 3) by periodic sediment removal (see Management Objective 2D) is important for the prevention of spread of Typha capensis into deepwater areas – a steep drop-off into deep water areas will further reduce invasion rate; 5. Invasion of marginal wetland areas can be limited by annual (summer) desiccation of these areas – the annual draw-down of vlei water levels should thus be implemented (Management Objective 4) 6. Regular cutting of *Typha capensis* stems will prevent the production of nuisance-causing seeds a. it is likely that a mechanical reed harvester will be required to undertake this if *T. capensis* becomes established in large areas of the vlei: - in the short-term, manual cutting of the plant should	Early dominance of *Typha capensis* in disturbed, open areas leading to limited opportunities for the establishment of other more conservation-worthy plants and habitats – this would have biodiversity and aesthetic implications; in the long term, senescent *Typha capensis* can result in a release of stored nutrients back into the water body	1-3: On sight and during monthly inspections of open space areas 4. See Management Objective 2D 5. Annually on 30 September 6. Two-yearly cycle: summer to autumn, and only outside of nesting season	Paardevlei Management Team

MANAGEMENT TACTIC	ACTIVITY	RISK OF INADEQUATE ACTION	FREQUENCY OF INTERVENTION	RESPONSIBILITY
	take place - in the medium term, access to a mechanical reed-cutter / weed harvester should be secured through hire or purchase; b. Harvested material must be removed from the vlei and disposed of appropriately; c. Harvesting of *Typha capensis* reedbeds, if extensive, may be phased so that the whole vlei area is never harvested at the same time, but pockets are harvested on a two-yearly cyclical basis.			
D. Control of other reeds [**Note:** Control of any reed growth must be carried out within the ambits of the overall management vision for Paardevlei – namely that the vlei should be managed as a seasonally inundated reedbed wetland; the temptation to manipulate the system into an open water wetland would be unsustainable, expensive and would create a system that is vulnerable to water quality impacts]	In addition to *T. capensis*, control of the extent of invasion *of Phragmites australis* and *Schoenoplectus littoralis* may be necessary or desirable at times, in order to provide localised habitat diversity through the creation of (temporary) areas of open water or to promote young reed growth. 1. Mechanical cutting using a reed harvester OR manual labour during the summer draw-down period should take place; 2. The entire reedbed should not be cut in any one season – if cutting is desired, reed-bed areas should be conceptually divided into 10 segments, and no more than one fifth of separated portions should be cut in any one year.	If no clearing undertaken: Long-term senescence of reedbeds that would naturally be maintained by fire and large herbivores If clearing too extensive: loss of habitat and breeding areas and opening up of areas for invasion by other plant species	Annually, and outside of the breeding season but no area to be cleared more frequently than every 5 years	Paardevlei Management Team
E. Control of *Potamogeton pectinatus* (pondweed) [Pondweed is a desirable element in the vlei, as it oxygenates the water column, provides habitat to a diversity of insect and other small wetland fauna; provides nesting habitat for birds, stabilises bottom	1. Pondweed harvesting must be carried out with a mechanical harvester, as approved in consultation with a wetland ecologist 2. Clearing of pondweed may not take place in areas where nesting is taking place 3. Canoeing routes must be selected in the vlei in consultation with a wetland ecologist and bird specialist	Reduced capacity for canoeing and loss of opportunity for active removal of nutrients stored in plant material	Annually, in late summer / autumn	Paardevlei Management Team

MANAGEMENT TACTIC	ACTIVITY	RISK OF INADEQUATE ACTION	FREQUENCY OF INTERVENTION	RESPONSIBILITY
sediments and potentially maintains the system in a state where phytoplankton (non-attached single celled algae) do not dominate; Pond weed does however often collect *Cladophora* algae on the water surface]	4. Canoeing routes comprising narrow swathes should be marked with permanent buoys and treated as follows: a. Pondweed in these routes must be maintained at a depth no deeper than 40cm below the surface; b. The canoeing routes must be of limited extent, as establishment of extensive Pondweed in the wetland is desirable from a water quality perspective 5. Pondweed control outside of the canoeing routes should take the form of annual cutting of the weed no more than 20cm below the water line – in principal, the weed should be allowed to spread throughout permanent open water areas 6. Cutting must ensure that plants are not uprooted and should take place after seeds are set (winter / spring) and after nesting periods 7. Cut pondweed must be removed from the wetland, in order to facilitate nutrient removal from the vlei			
F. Control of *Cladophora* spp. [*Cladophora* is a naturally occurring algal species that occurs in a wide range of salinities and nutrient enrichment. Prevention of *Cladophora* invasion is not realistic or achievable. It is often associated with pondweed]	1. Education of local communities must take place, to promote the concept that *Cladophora* is a natural part of the wetland ecosystem 2. Inhibition of algal production is possible in localized areas: barley straw bales should be purchased, packed in porous crates or bags and stowed at depth in the vlei in areas in which *Cladophora* is considered most problematic; note that a month's decomposition period is required before algal inhibitory material is released and that this tactic will work in limited areas only; 3. If desired, *Cladophora* can be hand-pulled from areas immediately adjacent to the western shoreline.	Complaints from an aesthetic perspective – these should be managed in terms of Management Objectives 5 and 6	Ongoing Barley straw bales to be installed annually in August – the bales take at least a month to start taking effect During peak production period – spring / early summer	Paardevlei Management Team
G. Control of physical habitat quality and diversity (depth,	1. Erosion nodes and nick-points (e.g. on inlet channels) must be attended to timeously, ideally using approaches such as earth shaping and planting with stabilizing		1.Spring / early summer to allow	

MANAGEMENT TACTIC	ACTIVITY	RISK OF INADEQUATE ACTION	FREQUENCY OF INTERVENTION	RESPONSIBILITY
hydroperiod) [Physical habitat diversity should be maintained as far as possible]	vegetation rather than structural measures to stabilize erosion points – measures to address erosion should ideally be carried out in collaboration with an engineer and landscape architect and/or wetland ecologist 2. The annual draw-down regime (see Management Objective 4) must be implemented, as this creates temporal variability in habitat type, and controls *T. capensis* invasion of seasonally dry areas 3. Periodic dredging of sediments from specific areas of the vlei must take place as per the specifications of Management Objective 2D 4. Periodic cutting of reeds to create small (< 30m diameter) open water habitats within the reedbeds could be undertaken during reed clearing exercises (see C and D above) – reeds should be cut off as close to their base as possible, and ideally uprooted along with their rhizomes ;	Decrease in biodiversity; creation of erosion gulleys into the vlei	time for plants to establish 2.Annually 3.See Management Objective 2D 4.Twice yearly, outside of the breeding season	Paardevlei Management Team
H. Management of ecological buffer areas	1. Ecological buffer areas must be established around the entire extent of Paardevlei, with widths determined in conjunction with a freshwater ecologist and taking cognizance of the nature and amplitude of impacts likely to derive from activities in adjacent areas; 2. Ecological buffer areas must be: a. Vegetated with locally indigenous vegetation only; b. Maintained free of alien vegetation; c. Managed so as to mitigate actively against impacts associated with the adjacent development areas – use of these areas should thus not contribute risk or actual additional impact to wetland systems; d. Designed so as to include only minimal hardened surfaces, restricted to minimal areas of (porous) pathway; e. Protected from grazing by cattle (see J below); f. Managed so as to minimize accessibility to dogs (and ideally, although practically difficult, cats) – dogs on leashes may accompany their owners round the broad perimeter walkways of the vlei but may not access	Degradation of wetland biodiversity and water quality impacts	1.Planning and development stages 2,Ongoing	Paardevlei Management Team Project planners Paardevlei Management Team Project planners Project landscapers

MANAGEMENT TACTIC	ACTIVITY	RISK OF INADEQUATE ACTION	FREQUENCY OF INTERVENTION	RESPONSIBILITY
	internal boardwalks / pathways into conservation areas; unleashed dogs are not allowed into conservation areas			
I. Management of ecological corridors	1. Ecological corridors must be: a. Vegetated with locally indigenous vegetation only; b. Maintained free of alien vegetation; c. Designed so as to maximize ecological connectivity and biodiversity function between important wetland and terrestrial nodes and corridors; d. Designed so as to include only minimal hardened surfaces, restricted to minimal areas of (porous) pathway; e. Protected from grazing by cattle (see J below).	Long-term loss of biodiversity	Planning stage and ongoing	Paardevlei Management Team Project planners Project landscapers
J. Control of cattle	*1.* Cattle must not be allowed to graze in the wetland or its buffer areas – they import nutrients into the wetlands and furthermore trample vegetation and spread alien seed material	Nutrient enrichment and wetland degradation	Ongoing	Paardevlei Management Team

MANAGEMENT OBJECTIVE 4:

Implement the hydrological regime implicit in the design of the vlei, including allowance for annual draw-down of water levels at the start of the dry season, and facilitation of inundation at the start of the wet season

Target criteria:	The specified hydrological regime must be implemented so as to create a seasonally inundated wetland, that fulfils a role in stormwater attenuation, provides a diverse and threatened wetland habitat type and limits invasion into shallow margins by *Typha capensis*

MANAGEMENT TACTIC	ACTIVITY	RISK OF INADEQUATE ACTION	FREQUENCY OF INTERVENTION	RESPONSIBILITY
A. Maintain hydrological regime between 5 and 4 mamsl through manual opening and closing of the outlet	1. The outlet structure **must** be closed in late autumn of each year (late April) to allow vlei to fill; 2. Prior to closure, at least one early wet season flush should be allowed to pass through the vlei, to facilitate flushing; 3. Outlet structure to be opened by 30 September of each year to facilitate summer drawdown; 4. Outlet structure to be maintained in working condition.	Failure of wetland design	1 - 3: April and 30 September each year 4. Dry season	Paardevlei Management Team
B. Facilitate rapid infill of vlei in wet season	During implementation phases, water from the Lourens River, via the Melck Sloot can be used to increase the rate of filling of the vlei in the wet season, subject to the following: 1. Supplementary water only to be added in the wet season inundation period – i.e. April to September; 2. The Melck Sloot must be cleared of litter and other contaminants prior to its use; 3. Establishment of wetland vegetation in the Melck Sloot will facilitate filtration of water; 4. Conditions of the DWA wateruse license to be complied with (e.g. abstraction volume); 5. At least three flushes of wet season water through the Lourens River need to have taken place prior to its use as a supplementary flow into Paardevlei.	Failure of wetland design Pollution of wetland	April to 30 September if necessary	Paardevlei Management Team
C. Facilitate extended draw-down of water levels to 4 mamsl or below in summer	Dry season irrigation water can be supplied down to a maximum depth of 4 mamsl or until salinity is such that it renders the water unsuitable for irrigation; pump locations to be as specified in Management Objective 2C	Invasion of wetted margins by *Typha capensis* if these are too wet in summer; *BUT: Typha* invasion of	Ongoing in summer	Paardevlei Management Team

MANAGEMENT TACTIC	ACTIVITY	RISK OF INADEQUATE ACTION	FREQUENCY OF INTERVENTION	RESPONSIBILITY
		deepwater areas if too shallow in summer		
D. Monitor water levels and soil moisture regime	1. A measuring device must be installed in the wetland to facilitate ongoing measurement of water levels throughout the year – the device should thus be located in the deepwater section of the wetland 2. Soil moisture measurements must be carried out at at least three sites on the vlei's marginal zones (purple and orange zones in Figure 3); soil moisture measurements could be based on peak dry season collection of soil samples for dry and wet weighing or based on installed soil moisture piesometers, with data read monthly in the dry season. The latter would be the preferred methodology.	Inadequate data to guide management activities	Monthly Annually to monthly in the dry season	Paardevlei Management Team

MANAGEMENT OBJECTIVE 5:

Manage the extent and impacts resulting from recreational and other use of the vlei by humans such that the considerable educational and recreational opportunities afforded by the wetland are effectively and productively harnessed, without compromising the biodiversity and conservation requirements of the wetland management objectives

Target:	The vlei should be seen as a valuable conservation and recreational asset.

MANAGEMENT TACTIC	ACTIVITY	RISK OF INADEQUATE ACTION	FREQUENCY OF INTERVENTION	RESPONSIBILITY
A. Instill early appreciation of acceptable and unacceptable uses of the vlei	1. Facilitate recreational use of the vlei and its precincts for walking, picnicking, bird watching and other passive recreation; the following management activities should be considered: provision of informative signage, bird hides, walkways and grassed open space areas if desirable *[**Note:** construction of walkways, bird hides and jetties in a wetland would require environmental authorization];* 2. Facilitate canoeing on the wetland through the provision of controlled parking and launch areas in accessible deepwater zones that will not impact on wetland conservation objectives; 3. Limit canoeists from the outset to buoy-demarcated routes in deepwater sections of the vlei only, and use sign boarding to highlight the presence, desirability and management strategy for pondweed in the wetland; 4. Ensure through sign-boarding and active monitoring that fishing does not occur in the vlei; 5. Ensure that no stocking of fish in the vlei takes place without full environmental consideration of its implications: in the event that stocking does occur, only indigenous fish species may be utilised, and these must not be suitable for fishing; 6. Ensure that activities such as sailing, motorboats, swimming do not occur in the vlei – there are human health and ecological management considerations implicit in this restriction.	Long-term non compliance leading to conflict in implementation of management plan	Ongoing	Paardevlei Management Team
B. Ensure that adequate	1. Provide and maintain a slipway for the easy launching of			

MANAGEMENT TACTIC	ACTIVITY	RISK OF INADEQUATE ACTION	FREQUENCY OF INTERVENTION	RESPONSIBILITY
safety and security facilities are available before communities are actively encouraged to utilise the vlei as a recreational area	canoes in a controlled area ***[Note:*** *construction and/or maintenance of a slipway into a wetland should require environmental authorization];* 2. Provide and maintain safe walkways, jetties and birdhides to facilitate recreational use of the wetland; 3. Ensure that input from a landscape architect, a wetland ecologist and a bird specialist is obtained in the siting and design of walkways, slipways, jetties.	Wetland degradation, uncontrolled access to the vlei; disturbance to wetland fauna and flora	During design and planning phases	Paardevlei Management Team
C. Manage the impacts associated with ongoing recreational use of the wetland	1. Ensure adequate provision for shore and water based collection of litter; 2. Ensure that people utilising the vlei precincts adhere to demarcated walkways and do not disturb birdlife in adjacent areas; 3. Control the access of dogs: a. no dogs may be permitted on or adjacent to walkways through bird-viewing areas; b. if dogs are permitted on walkways round the broader vlei margins they must be controlled on leashes at all times; 4. Ensure that adequate ablution facilities are available, are maintained in a high standard of cleanliness and are clearly demarcated and conveniently located, before the use of the vlei as a recreational asset is encouraged.	Degradation of aesthetic value of vlei Biodiversity impacts Human health impacts Safety and security impacts	1. Ongoing; weekly litter collection if necessary 2. Ongoing 3. Ongoing 4. Ongoing	Paardevlei Management Team
D. Management of plants	1. Management of plants that are considered aesthetically problematic may be allowed for on a localised level only, bearing in mind that the overall vision of the vlei is for a largely natural system; management of *Cladophora* algae and *Typha capensis* is possible within the vicinity of the "urban" edge of the vlei, but is neither realistic nor desirable at a larger scale. **Refer to Management Objective 3**	Failure to achieve Management Goals	Ongoing	Paardevlei Management Team

MANAGEMENT OBJECTIVE 6:

Manage perceptions in the local communities and the broader user group of the Paardevlei precincts such that the long-term management vision of the vlei as a natural seasonal wetland with conservation, aesthetic, educational and recreational value remains entrenched, and is not biased over time towards one or other user group

Target:	Obtain and maintain acceptance of the management vision for Paardevlei from both local and regional user-groups			
MANAGEMENT TACTIC	**ACTIVITY**	**RISK OF INADEQUATE ACTION**	**FREQUENCY OF INTERVENTION**	**RESPONSIBILITY**
A. Awareness raising	1. Consider any of the following: a. Invite officials from the City of Cape Town's Biodiversity, Nature Conservation and Catchment, Stormwater and River Management units to an open day at Paardevlei, at which conservation areas are show-cased; b. Present the proposed management and conservation plan to the Western Cape Wetlands forum for endorsement and awareness raising; c. Compile brochures and media releases outlining the dual contribution towards conservation and recreational facilities that will be played by Paardevlei in the future 2. Compile informative signposting and brochures for display / distribution at Paardevlei and its environs	Lost opportunities for positive endorsement	Initial phases and ongoing	Paardevlei Management Team
B. Community education	1. Engage pro-actively with present and future landowners / tenants regarding the proposed management vision for Paardevlei, including the rationale for the design of the vlei as a seasonal wetland system, the importance of the seasonal draw-down system, and the opportunities and responsibilities associated with use of the wetlands and open space conservation areas for recreational purposes; 2. Ensure that there is open acknowledgement of both positive and negative aspects of development in close proximity to a wetland, and attempt to gain buy-in to the notion that a healthy functioning wetland ecosystem will include a variety of fauna and flora, some of which may require lifestyle adaptations from human communities (e.g. screen doors / windows to manage against night time midges; adaptation to frog sounds; accommodation of sounds of adjacent birdlife etc).	Conflict over implementation of Management Plan and ultimate implementation failure	Initial phases and ongoing	Paardevlei Management Team

MANAGEMENT OBJECTIVE 7:

Implement an effective monitoring system, which allows the trajectory of the wetland in terms of meeting its ecological, hydrological, recreational, educational and aesthetic objectives to be monitored

Target criteria:	**Monitoring data must be adequate to allow clear-cut decision making around management activities.**

MANAGEMENT TACTIC	ACTIVITY	RISK OF INADEQUATE ACTION	FREQUENCY OF INTERVENTION	RESPONSIBILITY
A. Establish an effective long-term monitoring programme	1. A monitoring programme must be set up, which allows for the long-term collection, collation and interpretation of data relating to the following aspects of the vlei: a. Meteorological data (rainfall temperature etc); b. Hydrological data (seasonal water level fluctuations in the vlei) (as per Management Objective 4, Activity D) c. Sediment depth and quality (as per Management Objective 2, Activity G2); d. Water quality data for inflowing and in-lake conditions (as per Management Objective 2, Activity G1); e. Presence of and extent of invasive alien and indigenous vegetation; f. Fish population structure and size; g. Bird population structure, size and seasonal change; h. Seasonal and spatial changes in bird activities; i. Visitor numbers and comments; j. Perceptions of local landowners; 2. Review the monitoring programme on a three yearly basis in terms of parameters monitored, monitoring sites, monitoring methodology and sampling frequency and revise where necessary to ensure that monitoring programme continues to be suited to the requirements of the site and the problems at hand, without compromising on essential data required for long term predictions about ecosystem functions and response to change.	Failure to identify and rectify problems timeously, leading to potential long-term deterioration in vlei ecosystem and amenity value	Ongoing, as per individual monitoring component specifications	Paardevlei Management Team
B. Ensure effective communication of the	1. Compile regular, accessible reports on the results and implications of the different tenets of the monitoring			

outcomes of the monitoring programme and their implications for conservation, ecosystem health, aesthetics, recreation and other amenity values	programmes; 2. Engage or liaise with specialists in key disciplines to facilitate data interpretation, and timeous remediation measures when necessary; 3. Ensure regular feedback regarding ongoing management activities, challenges and achievements to local communities and other interested parties; 4. Ensure regular feedback to irrigation water uses regarding water quality, and salinity in particular. 5. Ensure that the City's E&HM Branch (District E) is kept informed of the outputs of the monitoring programme (e.g. they are provided with Annual monitoring reports) 6. Ensure that, as per their specific request, the City's E&HM Branch (District E) is informed of planned dates to implement draw-down of the vlei, and dates for closure of the outlet to allow wet season filling	Failure to identify and rectify problems timeously, leading to potential long-term deterioration in vlei ecosystem and amenity value	Ongoing, as per individual monitoring component specifications	Paardevlei Management Team
C. Ensure timeous and adequate responses to issues raised by the monitoring programme	1. Engage or liaise with specialists in key disciplines to facilitate data interpretation, and timeous remediation measures when necessary; 2. Implement remedial or other recommendations emanating from monitoring programme. 3. Allow for formal review of the OEMP and the outputs of the monitoring programme on a five yearly basis 4. Communicate the outcomes of the review process with the City's E&HM Branch and other relevant role players.	Failure to identify and rectify problems timeously, leading to potential long-term deterioration in vlei ecosystem and amenity value	Ongoing	Paardevlei Management Team

6 CONCLUSIONS

This document has outlined a number of management objectives for Paardevlei, and furthermore provided input into the kinds of activities that need to be carried out, and at what frequency, in order to achieve these objectives. It is clear that significant ongoing management input will be required for the wetland, and that without such input, its long-term positive contribution to the surrounding area is likely to be compromised. Initiation of the management activities outlined in this document is thus seen as an urgent measure.

It is noted however that a second level of management planning is likely to be required by the Paardevlei Management team. This level of planning would need to outline actual specifications for each activity, and assign particular individual responsibility and budgets to these tasks.

Finally, it should be stressed that long-term management of a wetland such as Paardevlei is an iterative process, and amendments to the management activities outlined in this document are likely to be required, as the vlei enters its operational phase and in the context of future developments in the surrounding area.

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