WETLAND OFFSET REPORT: MONTCLAIR DEVELOPMENT, ERF 776, MANDALAY IN CAPE TOWN

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1. Introduction

A water use licence application for Section 21 c and i water uses on Erf 776 Mandalay for the proposed "Montclair" Housing development was submitted to the Bellville Regional Office of the Department of Water Affairs on 17 May 2010 for consideration. The proposed development of the site will result in the loss of some wetland areas that are in a degraded state and are the result of historical sand mining of the site (Figure 1).

Further to the initial application and engagement with officials from the Bellville Regional Office, the option of a wetland offset in the development is to be considered. The wetlands have a low ecological importance and provide limited goods and services that relates largely to storm water management. One wetland system present within the site (described as a "Dune Strandveld Depression") was considered to have a moderate" ecological importance and sensitivity and has been retained within the public open space within the site layout plan.

The Department of Water and Sanitation requested that a wetland offset be investigated as mitigation for the wetland areas that are lost due to the proposed development. This report assesses the potential for a proposed wetland offset within the development site and provides recommendations relating to the design, implementation, management and monitoring thereof.

Figure 1. Layout plan for the development of Erf 776 Mandalay, overlaid in Google Earth on the mapped wetland areas

2. Description of the Affected Wetland Areas

The background to the wetlands and the initial site investigation was provided in the application and is detailed here accordingly: - "The site contains a mosaic of small wetlands surrounded by old dunefields that are degraded in areas, particularly towards the southeast and southwest of the site. The wetlands occur within depressions within the site and are mostly seasonally inundated. Most of the wetland areas have been created by previous sand mining activities that resulted in depressions in the landscape that are covered with the invasive alien Kikuyu grass (*Pennisetum clandestinum*) and the indigenous Kweek grass (*Cynodon dactylon*), together with common reeds (*Phragmites australis*).

A largely artificial wetland area associated with stormwater discharge within a channel transecting the north-eastern portion of the site (Wetland 7 in Figure 2) is dominated by bulrushes *(Typha capensis)*. A more natural wetland area (Wetland 3 in Figure 2) occurs in the north of the site that overlies calcrete and tends to be dominated by the halophytic *Sarcocornia natalensis.* Grazing of livestock and the growth of invasive alien Port Jackson willows (*Acacia saligna*) have been the main impacts on the wetland areas. A summary table (Table 1) indicates the value of each of the wetlands shown on Figure 2."

Table 1. Summary of wetland features

Wetland feature	Conservation Importance	
	Rating	Key Drivers
Wetland Area 1: Seasonally inundated grass/*Phragmites* reed meadow	Low	Low ecological or functional value due to level of degradation and small size
Wetland Area 2: Seasonally inundated grass meadow	Low	Low ecological or functional value due to level of degradation and small size
Wetland Area 3: Seasonally inundated reed/ *Sarcocornia* wetland	Moderate	It may support red data species and it representative of regionally threatened habitat type
Wetland Area 4: Seasonally inundated grass meadow	Low	Low ecological or functional value due to level of degradation and small size
Wetland Area 5: Seasonal inundated grass meadow	Low	Degraded and small in size - thus does not provide ecologically or functionally significant wetland habitat in its current state.
Wetland Area 6: Seasonal inundated grass meadow	Low	Degraded and small in size - thus does not provide ecologically or functionally significant wetland habitat in its current state.
Wetland Area 7: Permanent *Typha* reedbed wetland	Moderate	Provides functionally significant wetland habitat because it is important in water quality amelioration and flood attenuation.

Figure 2. Delineated wetland areas within the proposed development site, mapped in Google Earth

A summary of aquatic ecosystem assessment (Belcher, 2010) and the recommendations at the time of submission of the application are provided below:

"The ecological condition of wetland features within the proposed development site is considered to be moderately modified to largely natural. Due to the small size of the wetland features and their slightly degraded state they are considered to have limited value from a goods and services point of view as well as in terms of their ecological importance.

The impacts of the proposed development on wetlands are expected to be of a moderate significance. The potential impacts are primarily loss of wetland habitat. Indirect impacts are harder to identify, quantify and assess, and typically occur at the operational phase, and concern aspects such as disruption of ecological processes and introduction of alien species.

The duration of the impact varies. Should wetland features 3 and 7 be retained, the impact on these wetlands should be short term (during the operational phase of the development) provided the mitigation measures are properly implemented. The loss of the other wetland areas would be a permanent impact. Intensity can be regarded as Low, and the status is negative. Extent can be regarded as mostly local (immediate site). A summary of the impacts is provided in the table below."

Figure 3a. View of Wetland 1

Figure 3b. View of Wetland 3

Figure 3c. View of Wetland 5

Figure 3d. View of Wetland 7

Table 2. Summary of the potential impacts of the proposed development on the freshwater ecosystems

Wetland features	Extent	Duration	Intensity	Probability	Significance without mitigation	Significance with mitigation	Confidence
Loss of wetland habitat	Development site – the greater impact of a loss of a certain wetland type could however be seen on a far wider scale	Short term to Permanent	Moderate to Low	High	Moderate -ve	Low -ve	Medium
Water quality impairment	Local	Short term to Permanent	Low	High	Moderate -ve	Low -ve	Medium
Flow modification	Local	Short term to Permanent	Low	Moderate	Low -ve	Low -ve	Medium

"Recommended mitigation measures relating to the proposed activities are:

1. The proposed subdivision for the development be reworked such that Wetland 3 can from part of the proposed public open spaces.
2. Retain Wetland 7 as is currently proposed in the subdivision for the development. Where possible, the wetland habitat should be better landscaped by increasing the sinuosity of the channel and increasing the habitat diversity. Removal of invasive alien plants along the banks of the feature should also take place.
3. Ensure proper management of the impacts of the development activities during the construction phase to prevent impacts on the wetland features retained.
4. Allocate an adequate buffer zone (minimum of 30m) to the Wetland 3 to protect it from surrounding impacts such as storm water runoff, dumping of waste, trampling.
5. If possible maintaining a corridor between Wetland 3 and the private open space that will be maintained for the Eskom power lines to ensure that the hydrodynamics the maintains the wetland character is not interfered with.
6. Maintain an invasive alien plant removal programme.
7. Storm water runoff should be managed to ensure that it does not discharge into the Wetland 3. Only higher volumes of runoff that are generated during the winter rainfall period should be allowed to discharge to the wetland area."

The recommendations above have been adopted into the proposed layout with the only minor change being that of Wetland 7 which is the storm-water channel. The City of Cape Town have instructed that the channel be piped in terms of their Master Storm-water Management Plan. The proposal has complied with this request with only the section under the general residential (social housing) sites being piped. The balance of the channel is to remain open to continue its function in water quality amelioration and flood attenuation.

3. Wetland Offset Requirement

The total surface area of the wetlands to be filled in to allow the proposed development of the site is 1.05 ha. Due to the fact that these wetland areas are all relatively small, fragmented and highly degraded, their functional value is 20% and the habitat intactness is 40% as determined in the calculations below. The key service provided by the wetlands is stormwater mitigation.

Determining wetland offset targets

Note: Cells where information must be entered are highlighted in grey

Wetland Functionality Targets

Impact Assessment	Prior to development	Wetland size (ha)	1.05
		Functional value (%)	20
	Post development	Functional value (%)	0
		Change in functional value (%)	20
	Key Regulating and Supporting Services Identified		stormwater mitigation
	Development Impact (Functional hectare equivalents)		0.2
Offset calculation	Offset Ratios	Triggers for potential adjustment in exceptional circumstances	None
		Functional Importance Ratio	1.0
	Functional Offset Target (Functional hectare equivalents)		0.2

Further considerations	Have other key Provisioning or Cultural Services Identified that require compensation?	No
	Additional compensatory mechanisms proposed	None

Ecosystem Conservation Targets

Impact Assessment	Prior to development	Wetland size (ha)		1.05
		Habitat intactness (%)		40
	Post development	Habitat intactness (%)		0
		Change in habitat intactness (%)		40
	Development Impact (Habitat hectare equivalents)			0.42
Determining offset ratios	Ecosystem Status	Wetland Vegetation Group (or type based on local clasification)		Cape Flats Dune Strandveld Depression
		Threat status of wetland	Threat status	EN
			Threat status Score	7.5
		Protection level of wetland	Protection level	Poorly Protected
			Protection level Score	1
			Ecosystem Status Muliplier	7.5
	Regional and National Conservation context	Priority of wetland as defined in Regional and National Conservation Plans	Not specifically identiifed as important	0.5
			Regional & National Context Multiplier	0.5
	Local site attributes	Uniqueness and importance of biota present in the wetland	Low biodiversity value	0.5
		Buffer zone integrity (within 500m of wetland)	Buffer compatability score	0
		Local connectivity	Low connectivity	0.5
			Local Context Multiplier	0.4
			Ecosystem Conservation Ratio	1.50
Offset Calculation	Development Impact (Habitat hectare equivalents)			0.4
	Ecosystem Conservation Ratio			1.5
	Ecosystem Conservation Target (Habitat hectare equivalents)			0.6

4. Wetland Offset Targets and Objectives

The study site is located within an area of regional and global botanical significance, and also within the urban edge of a rapidly developing city with high demands on developable open space. The site contains the vegetation type, Cape Flats Dune Strandveld (Mucina & Rutherford 2006) which is considered to be Hardly Protected and Endangered. Almost all of this Endangered vegetation type falls within the City's boundaries. Of the 60% remaining, only 5 to 6% of the historical extent (54,5 ha) is formally protected.

Species Conservation Targets			
Species review and selection	**Desktop Evaluation:** Species flagged as potentially occurring at the site	**Species Name**	
		None observed - features dominated by Phragmites australis and Typha capensis with some Cyperaceae sp. which are all considered to be species of least concern, other species present: in wetlands *Cyperus longus; Ficinia cf.; Ficinia nigrescens; Hellmuthia membranacea;*	
	Specialist assessment: Species of conservation concern identified as requiring offset activities	**Species Selected**	**Rationale for species selection**
		None	

Target Species 1:		**None**	
Impact Assessment	**Impact measure**	Selected species impact measure	Habitat measure
		Selected unit of measurement	ha
		Description and rationale for species impact measure selected	
	Prior to development	Species impact measure	**40**
	Post development	Species impact measure	**0**
		Change in species impact measure	**40**
	Development Impact (Species impact measure)		**40**
Determining offset ratios	**Offest Ratios**	Offset Ratio	**1.0**
		Description and rationale for offset ratio selected	
		Species Conservation Ratio	**1.0**
Offset Calculation	**Development Impact (Species impact measure)**		**40.0**
	Species Conservation Ratio		**1.0**
	Species Conservation Target (Species measure)		**40.0**

None species of conservation importance were observed within the existing wetland features that are to be filled in. They are dominated by *Phragmites australis* and *Typha capensis* with some Cyperaceae sp. which are all considered to be species of least concern, other species present: in wetlands *Cyperus longus; Ficinia* cf.*; Ficinia nigrescens; Hellmuthia membranacea; Orphium frutescens; Linum africanum; Chondropetalum tectorum* and *Willdenowia teres.*

5. Description of Proposed Wetland Offset Site

The proposed wetland offset is to be located in the south-eastern corner of the site within approximately 0.58 ha of public open space (see Figure 5). This area is dedicated for a stormwater attenuation pond and a depression has already been constructed within the area. Due to the underlying clayey soils within the area, wetland characteristics are already developing within the depression and a number of wetland related vegetation is growing within the depression. Bulrushes currently dominate the permanently wet areas while the drier areas are dominated by grasses and Port Jackson willows. Patches of low growing sedges such as vleigras (*Isolepis prolifera*) are growing within the transitional areas.

Figure 4. View of the upper (top) and lower (bottom) portions of the pond created within the site

Figure 5. Extent and location of proposed wetland offset

6. Assessment of suitability of proposed stormwater pond as wetland offset

The proposed wetland offset meets a number of the wetland offset targets and objectives determined in Sections 3 and 4 and most importantly, it will be located within the same area and is within the same vegetation type and be of the same wetland type as the wetland areas that would be lost. It will also provide the same ecosystem goods and services as that of the wetland areas to be lost. Due to the degraded state of the existing wetland areas that would be lost, the opportunity exists to improve on the current situation.

Contribution Towards Wetland Functionality Targets

Wetland attributes	Wetland Reference		**Stormwater ponds within Mandalay site**	
Alignment with site selection guidelines	**Criterion**	**Relevance**	**Site attributes**	**Acceptability Guidelines**
	Wetland type	Targeted wetlands should typically be of the same type to ensure that similar services to those impacted are improved through offset activities.	Wetland is of the same type as the impacted wetland.	Ideal
	Key services targeted	Targeted wetlands should be prioritised and selected based on their ability to compensate for key regulating and supporting services impacted by the proposed development.	Selected wetland is well placed to contribute meaningfully towards improving key regulating and supporting services identified.	Ideal
	Offset site location relative to impacted wetland	Targeted wetlands should ideally be located as close to the impacted site as possible.	Selected wetland is located within the same local catchment as the impacted wetland.	Ideal
	Overall comment on alignment with site selection guidelines	Suitability and sustainability of the selected site for the wetland offset is ideal as it lies within the same site and is specifically intended to provide the functionality that is intended by the offset.		
Preliminary Offset Calculation	**Prior to offset activities**	Wetland size (ha)	0.58	
		Functional value (%)	0	
	Following sucessful offset implimentation	Functional value (%)	100	
		Change in functional value (%)	100	
	Preliminary Offset Contribution (Functional hectare equivalents)		**0.6**	
Final Offset Calculation	**Criterion**	**Relevance**	**Offset activity**	**Adjustment factor**
	Types of offset activities proposed	The risk of offset failure is linked to the type of offset activity planned with wetland establishment considered less preferable and more risky than rehabilitation or averted loss activities.	Establishment & Protection	0.33
	Final Offset Contribution (Functional hectare equivalents)		**0.2**	

Contribution Towards Ecosystem Conservation Targets

Wetland attributes	Wetland Reference		Stormwater ponds within Mandalay site	
	Wetland Vegetation Group (or type based on local clasification)		Cape Flats Dune Strandveld Depression	
	Threat status of wetland		Threat status	**EN**
Alignment with site selection guidelines	**Criterion**	**Relevance**	**Site attributes**	**Acceptability Guidelines**
	Like for Like	Targeted wetlands should be aligned with "like-for-like" criteria to ensure that gains associated with wetland protection are commensurate with losses.	Wetland is of the same wetland type within the same wetland vegetation group	Ideal
	Landscape planning	To what degree is wetland selection aligned with Regional and National Conservation Plans	Wetlands have not been specifically identified as important in landscape planning	May be acceptable
	Wetland condition	The habitat condition of the wetland should ideally be as good / better that that of the impacted site prior to development (or at least B PES Category in the case of largely un-impacted wetlands)	Final habitat condition is likely to be better than that of the impacted wetland.	Ideal
	Local biodiversity value	Wetlands that are unique or that are recognised as having a high local biodiversity value should be prioritised for wetland protection.	The wetland is charachterised by habitat and / species of low biodiversity value.	Not ideal
	Viability of maintaining conservation values	Connectivity and consolidation with other intact ecosystems together with the potential for linkage between existing protected areas is preferable.	The wetland is poorly connected with other intact ecosystems.	Not ideal
	Overall comment on alignment with site selection guidelines	The wetland area to be offset as well as those typical to the area are generally considered to be of a low conservation value. Connectivity within the area is also problematic as much of the target area is being urbanised		
Preliminary Offset Calculation	Wetland areas to be secured	Wetland size (ha)	**5.7**	
		Habitat intactness (%)	**90**	
		Wetland habitat contribution (hectare equivalents)	**5.1**	
	Buffer zones to be secured	Area of wetland buffer zone included in the wetland offset site	**10**	
		Integrity of buffer zone	**0.5**	
		Buffer zone hectare equivalents	**1.3**	
		Buffer zone contribution (hectare equivalents)	**1.3**	
Final Offset Calculation	**Criterion**	**Relevance**	**Site attributes**	**Adjustment factor**
	Security of tenure	Offset activities that formally secure offset sites for longer than the minimum requirement are more likely to be maintained in the long-term and are therefore preferred.	Minimum acceptable security of tenure for shortest acceptable period	1
	Offset Contributions	Wetland habitat contribution (hectare equivalents)	5.1	
		Buffer zone contribution (hectare equivalents)	1.3	
		Functional Offset Contribution (hectare equivalents)	**6.4**	

Contribution Towards Species Conservation Targets				
Target Species 1:		**None**		
Proposed offset activities	Description of offset activities proposed	Establishment of an offset		
	Rationale for proposed offset activities	Wetland areas to be lost not considered of any ecological importance. They have developed as a result of past excavation activities and do not contain any species of conservation value. They only provide some ecological goods and services that could be replicated elsewhere		
Preliminary Offset Calculation	Species impact measure	Selected species impact measure	Habitat measure	
		Selected unit of measurement	ha	
		Species impact measure (secured)	**80.0**	
	Preliminary species contribution		**80.0**	
Final Offset Calculation	**Criterion**	**Relevance**	**Site attributes**	**Adjustment factor**
	Security of tenure	Offset activities that formally secure offset sites for longer than the minimum requirement are more likely to be maintained in the long-term and are therefore preferred.	Minimum acceptable security of tenure for shortest acceptable period	1
	Risk of proposed activities	The risk of activities potentially failing to deliver desired outcomes should be taken into accont when assessing the potential offset contributions.	Low Risk	1
	Species Adjustment Factor			1
	Final Offset Contribution (Species measure)		**80.0**	

Table 3. Comparison of wetland offset target against the potential gains of the proposed wetland offset (stormwater pond system)

Component	Wetland Offset Target	Offset Area	Comment
Wetland functionality (Hectare Equivalent)	0.2	0.2	Offset meets wetland offset target in terms of wetland functionality
Ecosystem Conservation (Hectare Equivalent)	0.6	0.64	Offset exceeds wetland offset target in terms of ecosystem conservation
Species Conservation (Species measure)	40	80	Offset exceeds wetland offset target in terms of species conservation

According to the above tables, provided that the desired habitat and species diversity can be established within the proposed wetland offset within the proposed stormwater pond, the wetland offset requirements (as determined based on the wetland areas that would be lost) will be met.

In addition to the identified wetland offset, it is also the intention of the developer of the proposed development that the seasonally inundated reed / *Sarcocornia* wetland (indicated as Wetland Area 3) be retained and rehabilitated within a private open space in the development that is linked to the ESKOM corridor to the north of the site.

7. Wetland Offset Management Plan

7.1. Construction and Management of the Wetland Offset (Enhanced Stormwater pond)

In order to enhance the existing stormwater pond such that it can be considered as a proper offset for the wetland areas that will be lost, the following tasks will need to be undertaken:

***Task 1. Creation of a buffer protective area around the wetland offset area*:**

Due to the fact that the offset will be created within a built-up urban environment, it is recommended that the most effective buffer around the wetland is a gravel path around the area that will allow the surrounding residents to appreciate the area and encouraging them to use the formalised pathway rather than trampling the area. It will also prevent invasive kikuyu grass from growing into the area and assist with the longer term maintenance of the area.

The cost estimate for an approximate 2m gravel/laterite strip/buffer around the detention pond is ±R 150 000. The path will consist of pre-cast concrete (or other suitable) edging on the outer edge, if required, and then with the gravel going down the bank by approximately 1m.

***Task 2. Removal of invasive alien plants from the area*:**

Currently there is a moderate growth of Port Jackson willows (*Acacia saligna*) and kikuyu grass *(Pennisetum clandestinum)* that will need to be removed from the site.

Control Acacia saligna:

- *Cutting of plants*: Cut the larger trees, smaller trees and pull seedlings with an appropriate tool depending on the size of the plants;
- *Treatment of plant remainders with appropriate herbicide*: The application of the herbicide is essential to ensure the die back of the entire root system to prevent the re-growth or coppicing (forming of many shoots from stumps). Apply herbicide containing a colorant onto the remainder stumps and stems within 2 hours after felling or cutting with a brush or appropriate device, ensuring no spillage inside the wetland. Do not use a backpack pump and spay to apply the herbicide onto stumps or foliage and no general foliage herbicide spray should be used. Large volumes of herbicide mix should not be carried around in the area and regular refilling is rather advised. Unless stated herbicide/dye mixing concentrations and application rates for the different species are available from the suppliers. Material Safety Data Sheets for all chemicals and herbicides used must be available on site at all times. These documents contain vital information pertaining to environmental toxicity, health and safety regulations, flammability, storage instructions, procedures to follow in case of accidental ingestion and disposal methods; and
- *Removal of plant material from the wetland*: The plant material must be removed immediately after cutting and the trampling and compacting of soil in the remaining wetland vegetation should be avoided. The plant material that does not contain any seed can be chipped in a mechanical chipper

and used to cover areas on the property that are in need of cover or to suppress dust and to increase the organic content of the soil outside the wetland area. The removed material should be deposited in a designated area or applied for a particular purpose (i.e. dust suppression).

Control of Kikuyu Grass (Pennisetum clandestinum):

Kikuyu is very hard to remove because if any runners are left behind they will start growing again. It is best to poison Kikuyu with a foliar herbicide (e.g. Agil) during the summer growing season (before end March). When using herbicides, it is essential to apply the correct herbicide, in the right dose, at the right time, using the correct application method. Use only registered herbicides, follow manufacturer's instructions on the label, and wear the appropriate protective clothing during handling. All registered herbicides are labelled with important information to assist in selecting the correct product and give the recommended application methods and dose. Labels also provide safety and poisoning information and recommended disposal methods. Follow-up with the removal of dead material.

Task 3: Follow up work to prevent regrowth and seed germinating:

With most alien invasive plant control programs, it is necessary to do alien plant removal from the site more than once to get the invasive plant population(s) under control. When invasive plants are killed (for example, by spraying) or physically removed (for example, digging out or hand pulling), this can create conditions that stimulate further germination of the seeds lying dormant in the soil. For weed control to be successful, follow-up weeding is essential to ensure the new batch of invasive plants does not become established and out-compete regenerating indigenous plants or seedlings.

Follow-up alien vegetation control measures will need to be ongoing and for several years at least, depending on the site conditions, invasive plant species present and rate and success of regeneration or revegetation. Progressively less follow-up weeding should be required once indigenous plants are regenerating well and at a rate faster than the invasive plants can become re-established. Most invasive plant species maintain a soil seed bank for at least several years, and others will continue to re-invade until re-established native vegetation has reached sufficient density. A program of at least three years will be required to achieve maintenance level management; in almost all cases, weed control maintenance will need to continue over the long term.

***Task 4: Planting of cleared areas to prevent germination of seeds*:**

The cultivation of plant material to be planted within an area that requires replanting should only be done with species that are selected and that are suitable for the area and the type of habitat in which it would have the most optimal chance of survival.

***Task 5. Increase of biodiversity by adding plant species that would have naturally occurred in the particular habitat type and area*:**

Areas in need of restoration are often also depleted in terms of species diversity and full restoration will then require the addition of species that would have occurred in the particular area and specific micro habitats. Species selection for the re-introduction into an area should only be done after careful consideration of the following aspects: The selection of the species to prevent genetic contamination of exiting population and hybridisation; The type of habitats that needs to be vegetated; The likelihood of the survival of species; The resources required to ensure the survival (watering, protection against fire, removal of regrowth and germinations of seeds of alien vegetation); and The method of planting to optimise the formation of plant clusters (where appropriate).

Cost Estimate of the enhancement of the wetland offset area:

Wetland offset and storm water pond

Task number	Task description	Estimated costs
1	Removal of alien vegetation, mostly Port Jackson willows. Solid waste removal from the wetland area.	R 2 500
2	First treatment of kikuyu grass with herbicide (Agil) in the wetland area, before end March	R 2 000
3	Supply of plants (2000 plant at R6.50 per plant)	R 13 000
4	Planting of wetland plants in the wetland area	R 10 000
5	Second treatment of kikuyu grass with Agil herbicide	R 2 000
6	Follow up on the removal of port Jackson willows	R 2 200
7	Aftercare of wetland plants and addition of additional plants to the wetland area	R 2 500
8	Follow up 12 months after initial removal of Port Jackson willows	R 2 500
Subtotal		**R 36 700**
Vat		**R 5 138**
Total		**R 41 838**

7.2. Rehabilitation and Management of Wetland Area 3

Most of the above-mentioned measures for the enhancement of the wetland offset area are also applicable to the rehabilitation and management of Wetland Area 3. That is:

- The implementation of measures for the protection and use of the area such a fence around the area to ensure that there is access control, only allowing access to the wetland from inside the development and providing a boardwalk around the wetland that will enable the residents to utilise the area without trampling any sensitive wetland habitats. These activities would be undertaken within the 30m buffer zone around the delineated wetland area. These activities should be undertaken under the guidance of a wetland specialist.

Costing of the fence and boardwalk around the wetland area has still to be determined.

- Control of invasive alien plants within the wetland and surrounding buffer zone. Currently there is also a moderate growth of Port Jackson willows (*Acacia saligna*) and kikuyu grass *(Pennisetum clandestinum)* that will need to be removed using the measures recommended above. It is recommended that the buffer area around the wetland rather be planted with indigenous grasses and plants to prevent the reinvasion of invasive plant species.

Cost Estimate of the removal of invasive alien plants from Wetland Area 3:

Wetland Area 3 alien vegetation removal

Task number	Task description	Estimated costs
1	Removal of alien vegetation, mostly Port Jackson willows. Chipping of Port Jackson willows and Rooikrans. Assuming 1 ha of area including the buffer area.	R 34 000
2	First treatment of kikuyu grass with herbicide (Agil) in the wetland area, before end March	R 2 000
3	Second treatment of kikuyu grass with Agil herbicide	R 1 600
4	Follow up on the removal of port Jackson willows	R 4 400
5	Follow up 12 months after initial removal of Port Jackson willows	R 2 500
Subtotal		**R 44 500**
Vat		**R 6 230**
Total		**R 50 730**

8. Wetland Offset Monitoring Activities

A monitoring and evaluation system is proposed to track the success of the wetland offset and enhancement / rehabilitation activities in meeting the offset targets for habitats and species identified. The monitoring programme should only be designed once the management information requirements that are required to manage the aquatic ecosystems have been defined. This will ensure that the monitoring programme generates the required data from which information can be compiled to judge if the objectives listed below have been achieved. The recommended monitoring would apply to both the proposed wetland offset area as well as Wetland Area 3.

The following key elements should be monitored:

- Determine a baseline of the ecological condition of the rehabilitated / enhanced wetland areas from which the future monitoring can be compared
- Monitor the ecological condition of the wetland areas over time (on an annual basis during spring) using fixed point photography as well as wetland habitat mapping and integrity assessments;
- Monitor the invasive alien plant growth in the wetland areas on an ongoing basis, particularly during the growing season from spring to late summer, for a period of at least 3 years;
- Monitoring of the storm water drainage and solid waste disposal within the wetland areas to ensure adequate to protect and maintain the freshwater ecosystems?

9. References

Belcher, A. 2010. Freshwater Ecological Assessment: Proposed Construction of a Mixed Use Development in Mandalay, Cape Town

Macfarlane, D., Holness, S.D., von Hase, A., Brownlie, S. & Dini, J., 2014. Wetland offsets: a best-practice guideline for South Africa. South African National Biodiversity Institute and the Department of Water Affairs. Pretoria. 69 pages.