Proposed Infrastructure Upgrade and Rehabilitation of the Orlando Dam, Soweto, Gauteng Province

General wetland rehabilitation- and monitoring plan to mitigate construction related impacts

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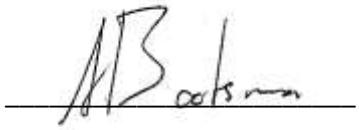
Declaration of Independence

I, **Antoinette Bootsma**, in my capacity as a specialist consultant, hereby declare that I -

- Act as an independent consultant;
- Do not have any financial interest in the undertaking of the activity, other than remuneration for the work performed in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- Undertake to disclose, to the competent authority, any material information that has or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the National Environmental Management Act, 1998 (Act 107 of 1998);
- As a registered member of the South African Council for Natural Scientific Professions, will undertake my profession in accordance with the Code of Conduct of the Council, as well as any other societies to which I am a member; and
- Based on information provided to me by the project proponent, and in addition to information obtained during the course of this study, have presented the results and conclusion within the associated document to the best of my professional judgement.



2020.02.14

Antoinette Bootsma (PrSciNat) Date

Ecologist/Botanist

SACNASP Reg. No. 400222-09

Indemnity

This report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken. The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information at the time of study. Therefore, the author reserves the right to modify aspects of the report including the recommendations if and when new information may become available from ongoing research or further work in this field, or pertaining to this investigation.

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1 INTRODUCTION

Limosella Consulting was appointed by Envirolution Consulting to undertake a wetland and/or riparian delineation and functional assessment to inform the Environmental Authorization, including authorisation from the Department of Human Settlement, Water and Sanitation (DHWS) for the proposed upgrade and rehabilitation of infrastructure of the Orlando Dam, Soweto, City of Johannesburg (Henceforth known as the study site) (Figure 1). As part of the specialist wetland input provided to inform the authorisation, a General Rehabilitation and Monitoring Plan was formulated.

Previous dam safety inspection reports, including the latest one from 2019 recommended that rehabilitation measures be implemented to ensure the continued safe functioning of the dam. The proposed works will essentially be rehabilitation of the existing structures. Reconstruction of the embankment crest might result in a nominal increase in height of the embankment. The existing spillway crest levels will remain as it is currently. The water level in the reservoir will therefore remain unchanged. The upgrades to the spillway will repair the damaged lining but the spillway capacity will remain unchanged.

Fieldwork was conducted on the 10th of February 2019.

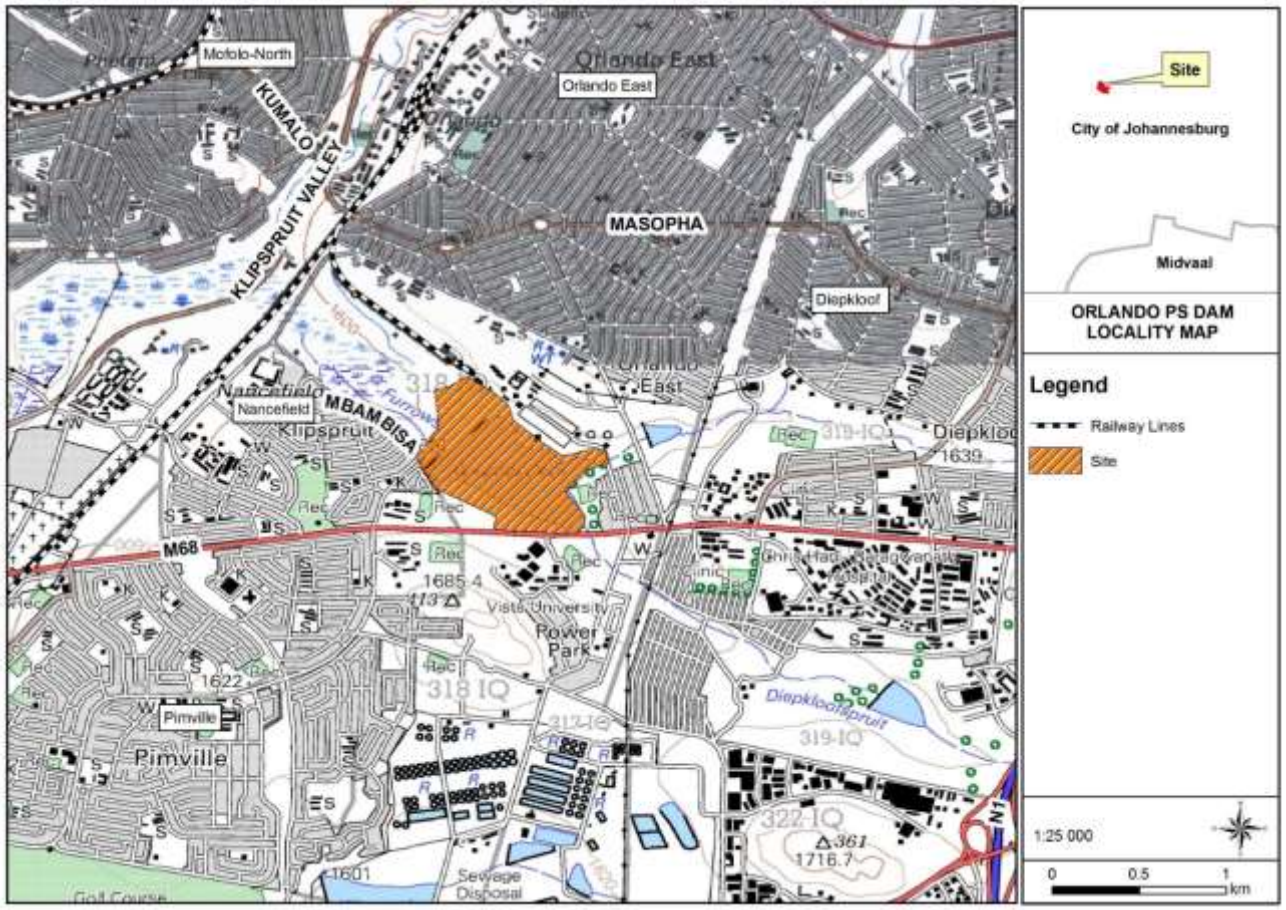


Figure 1. Locality of the Orlando Dam

1.1 Assumptions and limitations

- This document is based on information as received by Envirolution Consulting
- The document takes into account likely impacts that can arise during construction, as well as impacts that could arise as a result of the completed construction and operational phase. However, some unique impacts may arise that must be recorded during monitoring and appropriate corrective actions taken.
- Engineering drawings and the specification of rehabilitation structures falls outside of the scope of this general rehabilitation plan.
- This report recognises that construction includes:
    - Repair/replace and strengthen displaced, damaged and missing interlocking Armorflex blockwork on the training walls of the Auxiliary Spillway.
    - Backfilling of the trench along embankment crest. This can be temporary measure until the NOC has been reconstructed to currently accepted engineering standards for embankment dams.
    - Rehabilitation and/or total reconstruction of the upstream face of the embankment from a level below where benching has commenced to NOC level and protected with properly designed riprap.
    - Rehabilitation and/or total reconstruction of the upper 1.8 m (at least) of the NOC of the embankment.
    - Rehabilitation and/or total reconstruction of the downstream face of the embankment with a blanket chimney drain and backfill of imported embankment to reinstate the downstream face of embankment to design slope of 1.0V:2.0H.
    - The right-hand training wall of the Auxiliary Spillway should be raised to NOC level and extended in a downstream direction.
    - Rehabilitation of the 600 mm diameter outlet pipe and control valve.

1.2 Objective and aims

The wetland rehabilitation and monitoring plan is specific to the proposed upgrade of Orlando Dam, including construction upslope that could impact on the wetlands down the slope. Several existing impacts to the wetlands relevant to this project are described in Limosella Consulting (2020), including loss of wetland habitat and the alien invader plant density. The rehabilitation efforts proposed in the current document are unlikely to improve the Present Ecological State (PES) or the Ecological Integrity and Sensitivity (EIS) of the watercourses on site (e.g. improve the PES from E to a D). However, this document aims to limit localised impacts relating to the construction and to prevent further degradation of the watercourses in the catchment. It also aims to encourage local improvements on the study site and immediate surrounds.

The overall objective is to return the wetlands in and around the footprint of the dam to a state as close to the state prior to construction and to limit or negate any construction and operational associated impacts by:

- Ensuring the footprint of the impact on the watercourses is as small as possible;

- Ensuring that the planning phase takes wetland rehabilitation and monitoring into account for both the construction and operational phase;
- Ensuring that the upgrade of the Orlando Dam does not lead to any further degradation in the PES of the downstream watercourse;
- Employing preventative measures during the construction phase;
- Providing guidance on rehabilitation of areas that are temporarily disturbed during construction;
- Reducing the likelihood of erosion and subsequent sedimentation during construction and operation; and
- Recommending monitoring and corrective actions in order to mitigate impacts as soon as they become apparent.

2 METHODOLOGY

In order to protect biodiversity and conserve sensitive environments during development, steps that should be followed are to firstly avoid, then minimize, then repair or restore, and finally compensate for, or offset the negative effects of any development on biodiversity (Figure 2) (Macfarlane *et al*, 2014). Thus where the impact is unavoidable, the impacts must be minimised and the unavoidable and unforeseen impacts restored or rehabilitated.

Figure 2: The mitigation hierarchy

Rehabilitation refers to the measures that are undertaken to return impacted areas to their pre-impact natural state and can occur as an on-going and integral activity during the construction activity. From the perspective of minimizing impacts on biodiversity and ecosystem services, on-going rehabilitation to indigenous vegetation during the construction is preferred as it effectively reduces the time lag during which negative impacts endure. In order to realise the objective of the rehabilitation plan, it is necessary to limit the impact as much as possible to reduce the need for costly rehabilitation and corrective action. Therefore, mitigation should already start in the planning phase in order to direct construction to have the least impact possible, reducing follow-up rehabilitation and corrective actions. Therefore, this rehabilitation document comprises of three plans (Table 1):

1. Mitigation Plan: to focus pre-construction planning and activities on limiting the possible impacts that can arise during construction.
2. Rehabilitation Plan: aimed at rehabilitating the areas temporarily disturbed by the construction. This document recognises that construction will entail three phases.
3. Monitoring Plan: aimed at monitoring the success of rehabilitation as well as recording any impacts that may arise during the operational phase of the road (including maintenance), for which corrective action is needed.

Table 1: Plans in relation to the relevant project phases

Plan	Project Phases
1. Mitigation plan	• Pre-construction planning and activities • Construction • Operation
2. Rehabilitation plan	• Construction • Operation
3. Monitoring and corrective action	• Construction • Operation

3 DESCRIPTION OF ENVIRONMENT AND WATERCOURSES AFFECTED

The study area contributes to an urban built up environment. The watercourses flowing into the dam are used in large for subsistence farming. The study site is further located south of the Johannesburg mining belt area. This area has been extensively mined for the better part of a century and wetlands and rivers flowing through the area are subject to significant pollution. The area is also disturbed by various anthropogenic activities such as dumping and littering and infrastructure encroachment onto specialised habitats. The vegetation composition is mainly exotic with only a few pioneer species colonising the area. Furthermore, informal settlements have encroached into the wetland in some areas further degrading the wetland system.

3.1 Wetland/Riparian Classification and Delineation

The watercourse recorded on the site was classified as a large dam area constructed on the confluence of two small channelled valley bottom wetlands (Figure 7). When the water exits the constructed dam it forms an unchannelled valley bottom wetland with elements of floodplain wetland characteristics. The aforementioned area is thus described as a dam within a wetland system. The construction of the Orlando Power station started in 1939 and the wetland has thus been impacted on for 81 years or longer. Not only does the wetland have numerous impoundments, trenches but it also has numerous stormwater drains and canals entering and exiting the wetland. Leaking sewerage is also an issue. The system is subsequently greatly altered from the theoretical natural state. The hydrology, geomorphology and vegetation has changed significantly, however, the wetland and dam provide habitat and breeding ground for a variety of faunal species, especially avifaunal species.

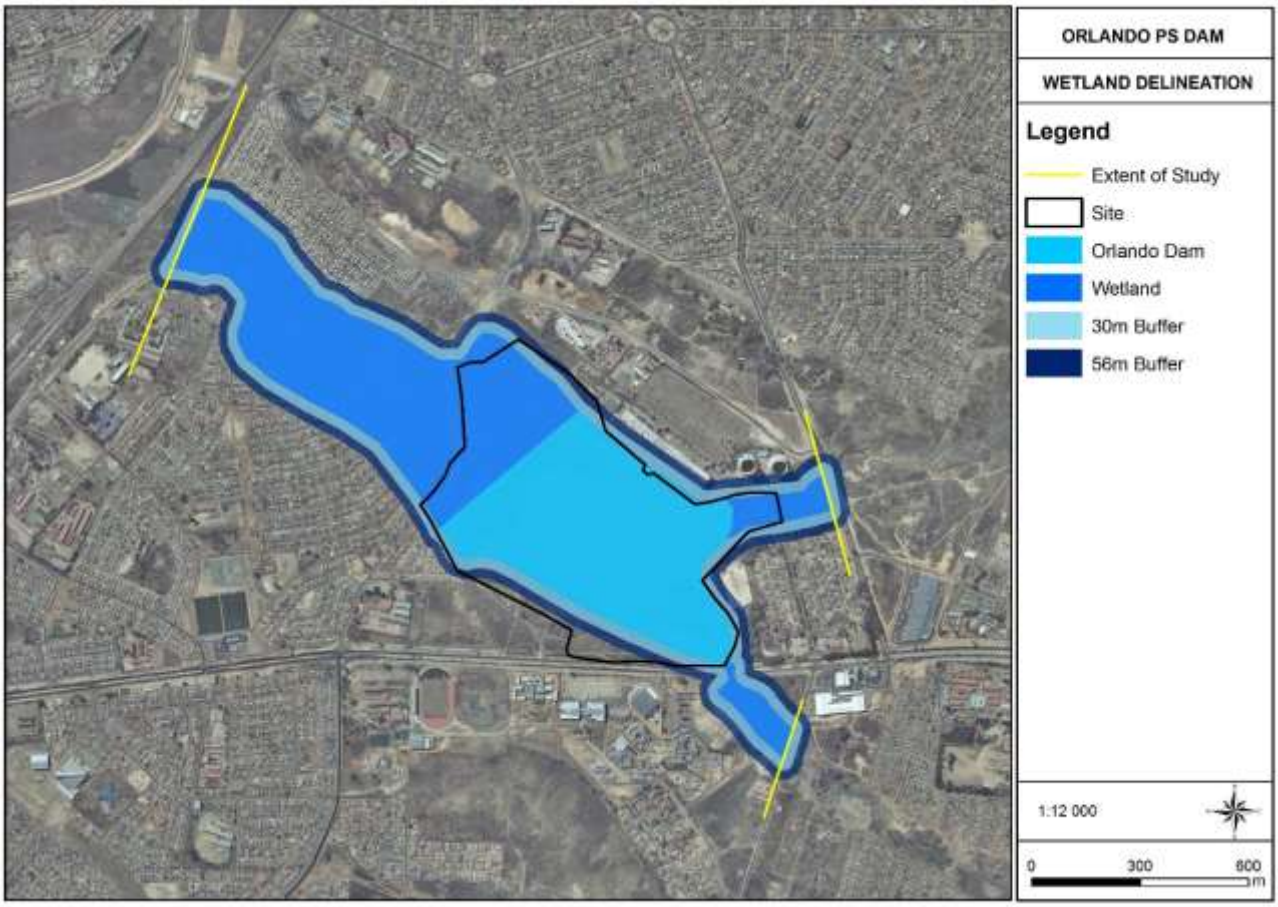


Figure 3: The delineated wetland associated with Orlando Dam

3.2 Functional Assessment

Present Ecological Status (PES)

The wetland scored a PES of **E - Largely modified**. The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable. The wetland conditions recorded on the study site are likely to remain stable over the next 5 years. This is due to the prolonged altered state of the wetland area, although it is likely that the vegetation composition will deteriorate slightly over the next 5 years given the amount of exotic species located on the study site that tend to grow into dense exclusive stands. The PES scores of the wetland are reflected in Table 2 below.

Table 2: Summary of hydrology, geomorphology and vegetation health assessment for wetland on the study site (Macfarlane *et al*, 2009).

Wetland Unit	Hydrology		Geomorphology		Vegetation		Overall Score	
	Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score	Impact Score	Change Score
Channelled Valley Bottom	7.6	0	7.1	0	6.5	-1	7.4	0
PES Category and Projected Trajectory	E	→	E	→	E	↓	E	→

Ecological Importance and Sensitivity (EIS)

The EIS score of **1.3** for the wetland falls into a category characterised by **Moderate** ecological importance and sensitivity. Wetlands that fall into this category are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water in major rivers (DWAF, 1999). The dense stands of vegetation are likely to contribute in some degree to the hydro-functionality of the wetland and is likely to enhance water quality to some degree although it is likely still very much pollute and unsuitable for human consumption or use explaining the low score for human benefits (Table 3).

Table 3: WIS including EIS scores obtained for the wetland on the study site. (DWAF, 1999).

WETLAND IMPORTANCE AND SENSITIVITY	Importance	Confidence
Ecological importance & sensitivity	**1.3**	**3.0**
Hydro-functional importance	1.4	2.5
Direct human benefits	0.2	3.0

WetEcoServices Kotze *et al* (2006)

The ecosystem services provided by the wetland on the study site is summarised in the table below (Table 4). The table lists scores from the lowest scores to the highest. The threats to the wetlands are very high as a result of exotic plant invasion however, there exists several opportunities to enhance the wetlands such as mechanical enhancement and removal of exotic vegetation.

Table 4: Results and brief discussion of the Ecosystem Services provided by the wetland on the study site.

Function	Score	Significance
Tourism and recreation	0.0	Low

Function	Score	Significance
Opportunities	0.0	Low
Education and research	0.5	Low
Maintenance of biodiversity	0.9	Low
Cultural significance	1.0	Moderately Low
Carbon storage	1.3	Moderately Low
Water supply for human use	1.3	Moderately Low
Streamflow regulation	1.8	Moderately Low
Natural resources	2.2	Moderate
Cultivated foods	2.2	Moderately High
Erosion control	2.4	Moderately High
Flood attenuation	2.6	Moderately High
Sediment trapping	2.7	Moderately High
Nitrate removal	2.8	Moderately High
Phosphate trapping	2.9	Moderately High
Toxicant removal	3.0	High
Threats	3.0	High

Recommended Ecological Category (REC)

Following Rountree *et al*, (2013), the REC score for the wetland is set at **D** since scores lower than this are considered unsustainable. However, it is unlikely that this category will be achieved unless large-scale rehabilitation is done and the hydrology of the watercourses is improved. This falls outside the scope of the proposed project.

4 EXPECTED IMPACTS

Construction activities necessitate work on and below the dam which lies within a watercourse. Repair and upgrade of the auxiliary spillway, repair and upgrade of the upstream and downstream face of the embankment as well as the upper section of the embankment and associated infrastructure will require work within the watercourse itself. These are activities that should be informed by careful design and intensive monitoring to ensure that no unintended negative impacts result on the local and downstream areas.

The most important potential impacts associated with this development include:

Exposure to erosion: Removal of stream bank vegetation, vegetation against slopes and compaction of soils, expose the resulting bare soils to erosion during rainfall events. Erosion removes the top soil layer, thereby preventing the successful establishment of indigenous vegetation on eroded soils. Eroded areas are likely to be colonised by alien invasive and pioneer plants, or in severe cases, no vegetation will establish causing high velocity runoff during rainfall events and continuous erosion. Furthermore, inappropriate stormwater input into the watercourse will alter natural flow and attenuation dynamics which may lead to erosion on site, or may contribute to cumulative catchment impacts and result in stormwater of downstream areas. It is important that monitoring form part of the project planning for the early detection and subsequent remediation of any erosion that may occur.

Sedimentation of wetlands: Loss of vegetation cover, soil erosion and direct sediment input could lead to increased sedimentation and turbidity downstream of the activity, which in turn reduce the water storage capacity thereof, smother vegetation, and decrease oxygen concentration. If sedimentation is allowed to continue, wetlands will lose their function and likely become invaded by alien invasive plant species.

Mobilisation of pollutants: Accidental pollution or illegal disposal and dumping of construction material such as cement or oil, as well as disposal or discharge of human (including partially treated and untreated sewage) into water resources will influence the water quality of watercourses, thereby influencing its functionality and the persistence of vegetation. Furthermore, the surrounding areas are already exposed to pollution which during high rainfall events could be washed into the wetlands – especially if vegetation cover is not sufficient to slow down water and filter pollutants.

Further impacts possibly associated by the dam upgrade include:

- **Changing the physical structure within a water resource**
- **Clearing/removal of natural vegetation, and**
- **Invasion by alien invasive vegetation.**

Relevant mitigation and rehabilitation measures are discussed in detail below.

5 MITIGATION PLAN:

On site mitigation can limit the impact of construction activities downstream and reduce the need for expensive rehabilitation and corrective action. In addition, sedimentation is very difficult and sometimes impossible to rehabilitate without further impacting on watercourses. Therefore, sedimentation should be prevented through mitigation. Table 5 list the mitigation measures that should be implemented during the planning and construction phase in order to limit the need for rehabilitation.

Table 5: Mitigation plan

Project Phase	Mitigation Objective	Mitigation to Limit Impact and Size of the Area to be Rehabilitated
Pre-construction planning	Limit the footprint of construction by Utilizing the smallest area on the watercourse crossing, thereby reducing compaction and destruction of natural vegetation	• Project engineers should compile a method statement, outlining the construction methodologies. The required mitigation measures to limit the impacts on the watercourse should be contained within the method statement. The method statement must be approved by the ECO and be available on site for reference purposes • Plan construction to take place during the drier winter months • Plan construction activities to have the smallest possible footprint • Minimise the width of the construction servitude across a wetland zone • Consider the various methods and equipment available to upgrade the dam and select whichever method(s) that will have the least impact on watercourses. • Demarcate the construction footprint prior to commencement of construction and ensure that all workers and contractors are aware that access beyond the demarcated areas are not allowed Where new access roads will affect a wetland, the edge / boundary of this wetland must be clearly demarcated in the field with poles, sticks, or any solid structure that will last for the duration of the development. These indicators could be coloured as follows and communicated to workers • Ensure that a copy of this and other applicable documents are available on site and that all workers and contractors are aware of it. Implementation thereof should be monitored by the appointed Environmental Officer (EO) or Environmental Control officer (ECO) • Plan construction activities that necessitate water crossings to only cross watercourses at designated points • Avoid linear disturbances that run parallel to a watercourse
	Limit the footprint of access roads and constructing camps, thereby reducing	• Plan construction activities that necessitate water crossings to only cross watercourses at designated points • Plan construction camps to be placed outside of watercourses and their associated buffer zones

Project Phase	Mitigation Objective	Mitigation to Limit Impact and Size of the Area to be Rehabilitated
	compaction and destruction of natural vegetation	
	Limit the impact on the hydrology and morphology of the wetland	• Project engineers should compile a method statement, outlining the construction methodologies. The required mitigation measures to limit the impacts on the watercourse and associated buffers should be contained within the method statement. The method statement must be approved by the ECO and be available on site for reference purposes • Do not allow excavations in close proximity to the wetland to stand open for longer than 2 days where at all possible. Excavations should preferably be opened and closed on the same day (DWAF, 2005) • Re-vegetation must be ongoing and relevant to terrestrial, wetness zone and slope
Construction	Limit the construction footprint and related impacts	• Minimise the width of the construction servitude across the wetland zone and demarcated the construction footprint prior to commencement of construction and ensure that all workers and contractors are aware that access beyond the demarcated areas are not allowed • Only use access roads as designated during the planning phase • Only cross watercourses at designated points should this be absolutely necessary • Limit the removal of indigenous vegetation in the construction footprint and do not remove vegetation outside of the construction footprint • Limit compaction by not working in wet conditions and limiting vehicular access. Ensure that all workers and contractors are aware of this • Do not permit vehicular or pedestrian access into natural areas or into seasonally wet areas during and immediately after rainy periods, until such a time that the soil has dried out (DAWF, 2005) • Only necessary traffic should be allowed within these demarcated areas • Contractors should refrain from impacting areas beyond the demarcated construction area • Minimise disturbance and loss of soil • The contractor must avoid traffic or storing of equipment and material in vegetated areas that will not be cleared
	Prevention of pollution	• The contractors must provide and maintain a method statement for “cement and concrete batching”. The method statement must provide information on proposed location, storage, washing & disposal of cement, packaging, tools and plant storage • Cement and plaster should only be mixed within mixing trays. Washing and cleaning of equipment should also be done within a bermed area (outside of the wetland buffer), in order to trap any cement or plaster and avoid excessive soil erosion. These sites must be rehabilitated prior to commencing the operational phase

Project Phase	Mitigation Objective	Mitigation to Limit Impact and Size of the Area to be Rehabilitated
Construction		• The mixing of concrete should only be done at specifically selected sites on mortar boards or similar structures to contain run-off into drainage lines, streams and natural vegetation • Materials such as fuel, oil, and paint must be sealed and stored in bermed areas or under lock and key, as appropriate, in well-ventilated areas • These substances must be confined to specific and secured areas within the contractor's camp, and in a way that does not pose a danger of pollution even during times of high rainfall • Storage of materials as described above may not be within the 1:100 floodline, watercourses or associated buffer areas • In the case of pollution of any surface or groundwater, the Regional Representative of the Department of Water and Sanitation (DWS) must be informed immediately • All equipment should be parked overnight and/or fuelled at least 500 meters from a watercourse • Drip trays (minimum of 10cm deep) must be placed under all vehicles that stand for more than 24 hours. Vehicles suspected of leaking must not be left unattended, drip trays must be utilised. • Drip trays must be utilised during repairs and maintenance of all machinery. The depth of the drip tray must be determined considering the total amount / volume of oil in the vehicle. The drip tray must be able to contain the volume of oil in the vehicle • Provision of adequate sanitation facilities located outside of the wetland area or its associated buffer zone • Remove all construction equipment and material on completion of construction • No water should be abstracted from the wetland without DWS authorisation
	Prevent/limit sedimentation	• Increased run-off during construction must be managed using berms and other suitable structures as required to ensure flow velocities are reduced; this must be done in consultation with the ECO • The contractor shall ensure that excessive quantities of sand, silt and silt-laden water do not enter watercourses. Appropriate measures, e.g. erection of silt traps, or drainage retention areas to prevent silt and sand entering drainage or watercourses must be taken • Silt trenches between the works area and downstream wetland could be used to trap any sediment washing off the works area and to prevent scouring of the stream line in case of heavy flows. This will provide protection for the downstream section of the wetland • Where wetlands are adjacent to the construction areas and these areas slopes toward the wetland, install sediment barriers along the edge of the construction areas as necessary to prevent sediment flow into the wetland • Sediment barriers must be properly maintained throughout construction and reinstalled as necessary until replaced by permanent erosion controls or restoration of adjacent upland areas is complete

Project Phase	Mitigation Objective	Mitigation to Limit Impact and Size of the Area to be Rehabilitated
Construction		• It is important that topsoil should be conserved in areas where bedrock is shallow to avoid sedimentation • Should water need to be pumped around the works area and discharged back into the wetland, care must be taken to ensure that the water is discharged in a manner that does not cause siltation or erosion downstream. As such it is recommended that any water to be discharged from pumping around the construction area or from dewatering operations be first discharged into a structure that allows the settlement of all suspended material, and which allows the diffuse discharge of water into the wetland. The water must be dissipated on re-entry into the wetland, to reduce the changes of erosion
	Preventing spread of alien invasive	• Alien invasive species that are identified within servitudes should be removed prior to construction related soil disturbances. This will prevent seed spreading into disturbed soils • Appointment of alien plant working group / assign this duty to specific staff • If herbicide must be used it should be registered for aquatic use • Acquire the necessary equipment for removal and control • Planned sequence of areas to be cleared of invasive plants • A register of the methods used, dates undertaken, as well as herbicides and dosage used must be kept and available on site. The register must also include incidents of poisoning or spillage • Ensure that contractors can identify the relevant plants and are aware of the removal procedures • Construction equipment must be cleaned prior to site access. This will prevent alien invasive seed from other sites to spread into disturbed soils • Manual removal methods are preferred to chemical control
Operation	Prevention of pollution	• In the event that maintenance must be carried out, all equipment should be parked overnight and/or fuelled at least 500 meters from a watercourse • Storage of maintenance materials / chemicals may not be within the 1:100 floodline, watercourses or associated buffer areas • The ECO must ensure that all construction equipment and material are removed on completion of construction
	Prevent/limit sedimentation	• The contractor shall ensure that a method statement is prepared prior to maintenance work to ensure that excessive quantities of sand, silt and silt-laden water do not enter watercourses. Appropriate measures, e.g. erection of silt traps, or drainage retention areas to prevent silt and sand entering drainage or watercourses must be taken • Plan monitoring during the operational phase to ensure that the construction footprint is adequately rehabilitated • Sediment barriers must be properly maintained throughout construction and reinstalled as necessary until replaced by

Project Phase	Mitigation Objective	Mitigation to Limit Impact and Size of the Area to be Rehabilitated
Operation		permanent erosion controls or restoration of adjacent upland areas is complete • Where maintenance work or emergency action must be undertaken and water needs to be pumped around the works area and discharged back into the wetland, care must be taken to ensure that the water is discharged in a manner that does not cause siltation or erosion downstream. As such it is recommended that any water to be discharged from pumping around the maintenance activity or from dewatering operations be first discharged into a structure that allows the settlement of all suspended material, and which allows the diffuse discharge of water into the wetland. The water must be dissipated on re-entry into the wetland, to reduce the changes of erosion
	Preventing spread of alien invasive	• Plan an alien invasive plant work group that can carry out follow-up alien plant control for at least three years after construction • Ensure that contractors can identify the relevant plants and are aware of the removal procedures

6 REHABILITATION PLAN

Rehabilitation in this document refers to the reinstatement of the temporarily disturbed areas affected by the construction or due to construction related activities, to a state that resemble the conditions prior to the disturbances. It therefore does not address the rehabilitation of the wetlands along the proposed dam upgrade from example a management category E to a D (Kleynhans, 1996 & Kleynhans, 1999). In order to improve the management category, the current impacts due to urbanisation and increased stormwater energy should be address and these fall outside the scope of this document.

Table 6 list the rehabilitation measures that should be undertaken post construction as well as corrective action when monitoring has established that the listed impacts are taking place.

Table 6: Rehabilitation plan

Activity	Rehabilitation	Time frame
Planning	• Reinstatement should proceed directly after closure of the excavated areas upslope of the wetland although revegetation may have to be postponed to the onset of the growing season • The rehabilitation plan must be made available to all parties involved. • Plan the areas to be rehabilitated in stages so as to work on one area at a time.	• Duration of rehabilitation activities relevant to areas where vegetation clearing has occurred upslope of the wetland
Access control	• Access must be restricted to as few people as possible. • All works should be supervised.	• Duration of rehabilitation activities
Site preparation	• Compacted and disturbed areas must be shaped to natural forms and follow the original contours. In general cut and fill slopes and other shaped areas must not exceed 1:3 (v:h) ratio. • Slopes for revegetation must be cleared of alien and invasive plants. • Manual / mechanical removal of alien plants is preferred to chemical control • If herbicide must be used it should be registered for aquatic use and prior approval obtained from the Environmental Control Officer. • Planned sequence of areas to be cleared of invasive plants • A register of the methods used, dates undertaken, as well as herbicides and dosage used must be kept	• Commence in early rain season (September to October)

Activity	Rehabilitation	Time frame
	and available on site. The register must also include incidents of poisoning or spillage • Soil heaps dumped on the immediate site can be used for filling areas for resloping. • The use of fertiliser should be avoided. Nutrient deficiencies are not expected to be present on the site. • Soils must be moist for revegetation activities. • Badly damaged areas should be fenced in to allow for rehabilitation to take place without further impacts on these areas	
Resloping	• In order to promote vegetation growth and establishment, the slope angle must be a maximum of 1(V):3(H). • Slope reshaping must follow the natural slope and topography of the surrounding undisturbed area and wetland to the east of the artificial channel. • Areas for resloping must be ripped or loosened to a depth of 150mm to prepare soils for revegetation and allow water penetration into the soils. • Ripping must be done manually with hand tools. • Ripping must be done during the late dry season to prevent erosion and collapse of the banks. • The original contours must be established over the pipeline. After the backfill has subsided, the contours must follow the surrounding contours to stop irregular flows, flow into surface cracks to the pipe or blockage of biotic movement	• As soon as possible after construction
Revegetation	• Areas where revegetation is required are expected to be very small. Therefore these areas can be allowed to revegetate naturally. • Where revegetation is slow or doesn't occur (as described in the monitoring plan below), active seeding of vegetation should be done. This should follow the following points: o A suitable grass mixture must be spread by hand along the extent of the slopes. The proposed grass species list and application rate is indicated in **Table 8** below. o Seeds must be thorough mixed before applying.	• Directly after resloping and no later than November, only if natural revegetation is unsuccessful

<table>
<tr><th>Activity</th><th>Rehabilitation</th><th>Time frame</th></tr>
<tr><td></td><td>

The seeds must be applied according to the required rates.
Application rates can be increased in areas that are unfavourable or steep, but no more than double the recommendations.
Seeds can be mixed with a spreading agent such as river sand, bran or finely sifted kraal to ensure even distribution.
Manure or agricultural lime and granular fertiliser mix can be applied prior to reseeding.
Once complete, the seeded area must be watered and patted down gently.
Indigenous vegetation removed from the area must be applied over the seeded area as mulch.

Table 7: Suitable plant species for seeding together with application rates
<table>
<tr><th>Species</th><th>Common name</th><th>Application rate (kg/ha)</th></tr>
<tr><td>Digitaria eriantha</td><td>Finger grass</td><td>8</td></tr>
<tr><td>Eragrotis curvula</td><td>Weeping love grass</td><td>4</td></tr>
<tr><td>Eragrostis tef</td><td>Tef</td><td>8</td></tr>
<tr><td>Imperata cylindrica</td><td>Cottonwool grass</td><td>8</td></tr>
<tr><td>Panicum maximum</td><td>Guinea grass</td><td>4</td></tr>
<tr><td>Total</td><td></td><td>36</td></tr>
</table>
</td><td></td></tr>
</table>

7 MONITORING PLAN

Monitoring refers to the repetitive and continued observation, measurement and evaluation of environmental criteria to follow changes over a period of time and to assess the efficiency of control measures. The monitoring plan aims to establish whether rehabilitation was successful, whether maintenance or related activities have impacts and whether the implementation of the proposed dam upgrade has detrimental impacts on the wetland after construction (Table 8). Five phases of monitoring is recommended:

Routine Monitoring:

1. Monitoring during construction: during construction, the mitigation measures put in place to limit or negate the construction related impacts on a watercourse must be monitored. Where these mitigation measures are not sufficient or breached, immediate corrective action should be taken.

2. Monitoring post construction phase: it is assumed that the construction will be phased and that rehabilitation is thus an ongoing effort as each phase is completed. For example, once a portion of dam has been upgraded and rehabilitated. Monitoring post construction is important to detect any erosion, sedimentation or faulty structures. As each phase is completed the area is monitored for impacts and corrective action taken where needed.

3. Seasonal monitoring: after construction is complete, rehabilitation success, as well as signs of erosion, sedimentation and the presence of alien vegetation should be monitored twice during the summer months: once at the start and once at the end of the rainy season. This should be continued for at least three years after construction was completed.

4. Rapid monitoring: For the first two years, monitoring should take place immediately after heavy rainfall to ensure that rehabilitated areas are intact and that no erosion and subsequent sedimentation took place.

5. Annual monitoring: after three years, provided that all rehabilitation where found to be successful and no additional problems arose, monitoring can take place once a year after the first seasonal rainfall.

Problems such as failed re-vegetation and erosion should be remediated as soon as it is recorded in the monitoring process. Corrective action should be taken and can include the re-initiation of rehabilitation in severe cases or by correction of the problem (e.g. mend broken fences).

It is recommended that fixed point photography is used to monitor vegetation and soil stability. This involves taking pictures of the areas monitored from the same point during each monitoring event. The images can be compared and serves as a record of the success of rehabilitation or the failure thereof.

Table 8: Monitoring plan

Variables	Methods	Monitoring Frequency	Indicator	Corrective Action
Hydrology of the wetland	• On-site inspection	• After construction and rehabilitation • Seasonal for the first three years and rapidly after heavy rainfall • Thereafter annually	• Water flow is not interrupted, diverted, changed by the rehabilitated area • Water flows though the rehabilitated area, not causing erosion	• Re-landscape the disturbed area to a state prior to the disturbance • Energy dissipaters if required
Integrity of rehabilitation structures - where utilised	• On-site inspection • Fixed point photography.	• After construction • Seasonal for the first three years and rapidly after heavy rainfall • Thereafter annually	• Arresting of erosion/head cut. • Sedimentation behind structure • Elevated (to near normal) water table level behind structure	• Structures should be fixed where possible or new structures should be implemented
Vegetation cover	• On-site inspection • Assess landscape functionality • Monitor species cover abundance and ensure that natural species cover increase(compare to vegetation study results prior to construction) • Fixed point photography	• After re-vegetation • Seasonal for the first three years and rapidly after heavy rainfall • Thereafter annually	• Spreading and distribution of dominant plant species in specified wet zones • Wetland re-vegetation shall be considered successful if the cover of herbaceous and/or woody species is at least 80 percent of the type, density, and distribution of the vegetation in adjacent wetland areas that were not disturbed by construction	• If natural re-vegetation does not occur replanting of indigenous plants should be done at sites of concern • If re-vegetation is not successful at the end of 3 years, develop and implement (in consultation with an ecologist) a remedial re-vegetation plan to actively re-vegetate the disturbed area. Continue re-vegetation efforts until wetland re-vegetation is successful • If wetland rehabilitation is successful at the end of 3 years, report on the status of the vegetation (e.g. using photographic record) and only monitor annually or if maintenance activities might have disturbed the area again

Variables	Methods	Monitoring Frequency	Indicator	Corrective Action
Plant species composition	• Fixed transect to determine the species composition	• Seasonal for the first three years and rapidly after heavy rainfall • Thereafter annually	• Presence/absence of species in specified wet areas.	• If natural re-vegetation does not occur replanting of indigenous plants should be done at sites of concern
Erosion	• On-site inspection • Fixed point photography • Compare to adjacent land	• During and immediately after construction • Seasonal for the first three years and rapidly after heavy rainfall • Thereafter annually.	• Areas where vegetation cover is limited or nil and where soil has started to erode • Bare soil patches or ditches • Stabilised head cut and gully erosion • Water table behind structure	• Should erosion occur, soft options such as hay bales, eco-logs and replanting should be considered, if erosion is too great for soft options then a rehabilitation method should be discussed with an engineer and wetland specialist
Sedimentation	• As determined by ECO • Visual observations and site inspections • Fixed point photography	• After construction • Seasonal for the first three years and rapidly after heavy rainfall • Thereafter annually	• Excess sediment in wetlands • Sediment behind structure	• Cause of sedimentation should be identified and dealt with appropriately • Should sedimentation be observed to accumulate and smother vegetation, a wetland specialist should be consulted to find a suitable solution for the specific wetland and its plant species composition.
Alien Invasive Plant Species	• Monitor the emergence of alien invasive plant species in or around rehabilitated areas • On-site inspection • Fixed point photography	• After construction • After re-vegetation • Seasonal for the first three years and rapidly after heavy rainfall • Thereafter annually	• Establishment of alien invasive plant species in rehabilitated areas or in watercourses	• Remove emergent invasive vegetation from the rehabilitated footprint and servitude as soon as it becomes apparent • Manual labour is preferred above chemical or manual removal. • Do not use herbicides or pesticides in or within 200 meters of wetland areas

8 INVASIVE PLANT SPECIES CONTROL PLAN

In terms of the NEMBA Regulation 75, landowners are required to manage all listed invasive alien species that occur on their land. The management of invasive plants (aquatic and terrestrial) can be dealt with by a landowner, but controlling invasive animals is more complex. Landowners are therefore advised to get in touch with their Local Municipality or Provincial Conservation Agency for advice and guidance on managing invasive animals. This report only covers invasive plant species and not animal species.

8.1 Definitions and Legal Framework

Conservation of Agricultural Resources Act (Act No. 43 of 1983)

In terms of the amendments to the regulations under the Conservation of Agricultural Resources Act (Act No. 43 of 1983), all declared aliens must be effectively controlled. Landowners are legally responsible for the control of invasive alien plants on their properties. In terms of this Act 198 alien species were listed as declared weeds and invaders and ascribed to one of the following categories:

- Category 1: Prohibited and must be controlled.
- Category 2 (commercially used plants): May be grown in demarcated areas provided that there is a permit and that steps are taken to prevent their spread.
- Category 3 (ornamentally used plants): May no longer be planted. Existing plants may be retained as long as all reasonable steps are taken to prevent the spreading thereof, except within the flood line of watercourses and wetlands.

National Environmental Management: Biodiversity Act, 2004 (Act No.10 of 2004)

The National Environmental Management: Biodiversity Act (NEMBA) regulates all invasive organisms in South Africa, including a wide range of fauna and flora. Regulations have been published in Government Notices R.506, R.507, R.508 and R.509 of 2013 under NEMBA. According to this Act and the regulations, any species designated under section 70 cannot be propagated, grown, bought or sold without a permit. The three categories are explained below:

- Category 1a: Invasive species requiring compulsory control. Any specimens of Category1a listed species need, by law, to be eradicated from the environment. No permits will be issued.
- Category 1b: Invasive species requiring compulsory control as part of an invasive species control programme. Remove and destroy. These plants are deemed to have such a high invasive potential that infestations can qualify to be placed under a government sponsored invasive species management programme. No permits will be issued.

- Category 2: Invasive species regulated by area. A demarcation permit is required to import, possess, grow, breed, move, sell, buy or accept as a gift any plants listed as Category 2 plants. No permits will be issued for Category 2 plants to exist in riparian zones.
- Category 3: Invasive species regulated by activity. An individual plant permit is required to undertake any of the following restricted activities (import, possess, grow, breed, move, sell, buy or accept as a gift) involving a Category 3 species. No permits will be issued for Category 3 plants to exist in riparian zones.

It is important to note that alien species that are regulated in terms of the Conservation of Agricultural Resources Act (Act 43 of 1983) (CARA) as weeds and invader plants are exempted from NEMBA. This implies that the provisions of the CARA in respect of listed weed and invader plants supersede those of NEMBA.

8.2 Purpose of the Alien Plant Management Plan

The purpose of the alien management plan is:

- To bring al invasive plants on the property under control by 2021 in order to be compliant with NEMBA regulations
- To improve the overall condition of the wetland and vegetation composition
- To avoid establishment of invasive species on the study site
- To establish a monitoring plan to detect invasive plant species and monitor previous invasive control success

8.3 Extent and distribution of the invasive species on the property

The study site has numerous invasive species throughout with a high concentration in the wetland. The exotic species include woody and herbaceous species. Invasive species have numerous impacts on the environment and includes: (DiTomaso, 2000 & Bromilow, 2010):

- Reduced water quality
- Reduced species richness
- Reduced water infiltration rate
- Influence soil moisture and nutrient availability
- Change in Fauna composition
- Extinction of indigenous species
- Ecological Imbalance
- Increased fire hazard
- Prevention of access
- Reduced land value

- Reduction in conservation and tourism
- Soil erosion
- Depletion of water sources
- Change in soil composition
- Aquatic weeds can lead to: Oxygen deficiency, provide breeding habitat for parasites, cause cattle to drown, prevent access of sunlight

It is thus imperative to manage all exotic species on the property.

All habitats can be affected by invasive plant species and the management of these invasive species can be problematic in some areas where invasion is greater. Some areas are more vulnerable to invasive species. The elimination of invasive plant species should focus on these areas that are more prone to invasive species infestations. These areas include:

- Wetlands, drainage lines and watercourses
- Areas with deep loose soil
- Areas surrounding any disturbances
- Areas with increased water run-off

8.4 Listed species present on the property

The invasive species recorded on the study site during the site visit, as well as those described in other literature are listed in the table below (Table 9). The NEMBA category is also indicated. Where an exotic invasive species was recorded that is not yet listed it is indicated as “not listed”. Where available the control method is also listed for the specific plant species. The plant species that are classified as category 1 plants are also visually illustrated. All invasive species located in the wetland on the study site should be treated as a category 1 invasive species.

Table 9: NEMBA listed (Oct 2014) IAS present on the property

Species	Common name	NEMBA Category	Control Method (Bromilow, 2010)
Argemone *ochroleua***.**	White-flowered Mexican Poppy	1b	Post emergence herbicide when small
Cirsium vulgare **(Savi) Ten.**	Scottish Thistle	1b	Hormone and contact type herbicide
Datura stramonium **L.**	Common Thorn Apple	1b	Post-emergence weed herbicide
Eucalyptus camaldulensis **Dehnh.**	River red gum	1b/2	Cut and treat stumps with suitable herbicide Soil, Foliar, frill and aerial

Species	Common name	NEMBA Category	Control Method (Bromilow, 2010)
			applications exists
***Mirabilis jalapa* L.**	Four-o'clocks	3	Physical Removal Systematic Herbicide
***Pennisetum clandestinum* Hochst. & Chiov.**	Kikuju Grass	2	Glyphosate
***Solanum mauritianum* Scop.**	Bugweed	1b	Cutting Stem Painting Soil or Foliar Herbicides
***Solanum sisymbriifolium* Lam.**	Dense-thorned Bitter Apple	2	Foliar application of Triclopyr
***Verbena bonariensis* L.**	Wild Verbena	Not Listed	Broadleaf Weed Herbicide
***Verbena officinalis* L.**	European Verbena	Not Listed	Broadleaf Weed Herbicide

9 OBJECTIVES AND ACTIONS

9.1 Objective 1: Control Invasive Plant infestation

Bring the Invasive Plant infestation on the property under control by 2029 (Table 10)

Table 10: Desired State for Invasive Plants on the property

Category	Desired state – by 2029
Category 1 b trees	All mature trees are removed; follow- up control programme in place. All the management units are in maintenance. Overall infestation does not exceed 10% of the property. (These will include seedlings and re-sprouting trees, mainly gums and poplars. Acacia species will be under control with the correct control methods) Removed trees replaced by indigenous trees as described in this report.
Category 1b herbaceous species	Less than 2%
Category 1b annual species	Less than 2%
Category 2 species	Permit application will be submitted for all Category 2 species on the property or species will be removed

9.2 Objective 2: Prevention

To put measures in place to prevent the introduction of new NEMBA listed Invasive alien species onto the property, and from spreading from the property to neighbouring properties.

Preventative actions

- No listed invasive and alien plant species will be planted
- Areas bordering onto neighbouring land will be prioritized for control to prevent existing invasive plants from spreading beyond the boundaries of the property
- No listed invader animal species will be introduced on the property
- These prevention measures will be communicated to all users of the property (where applicable)

9.3 Objective 3: Early Detection & Rapid Response (EDRR) and eradication

To detect emerging invasive alien species through regular surveys and remove them before they become established, produce seeds or offspring and start spreading.

Early Detection and Rapid Response and Eradication actions

- Regularly survey the property to detect any new or emerging listed invasive plant species
- Regularly survey the property to detect any new or emerging listed invasive animal species
- Learn more about the SANBI programmes and register as a spotter where applicable
- Report category 1a species immediately to the Department of Environmental Affairs/Provincial Conservation Agency/Local Municipality/South African National Biodiversity Institute (SANBI) EDRR programme and ask for assistance with the control of the species
- Do not allow emerging or new species to produce seeds or off-spring, or start growing vegetatively, act immediately by removing them
- Update the species list by including these species and indicate where on the property they were located
- Increase surveillance in the areas after the species were controlled to quickly remove re-sprouting plants or seedlings.

10 MONITORING

The following monitoring framework should be followed (Table 11):

Table 11: Monitoring Framework

WHAT	FREQUENCY	HOW	RESPONSE
How effective are the control methods?	4-6 months after every operation	Survey the cleared areas and look for regrowth. Before and after pictures are very effective. Look out for non-target effects of herbicide application.	If the survey reveals that the control methods are effective, e.g. low levels of re-sprouting, continue following the herbicide mixtures and control methods. If non-target plants are dying off where herbicides were applied, ensure appropriate training for herbicide applicators, demonstrate the off-target effects to herbicide applicators to ensure they are using the correct methods and herbicides. (Gums are difficult to control and re-sprouting often occurs, therefore shorter follow-up interventions may be required). If the results show that the control methods are not effective, adapt by e.g. cutting lower above ground or changing herbicides or timing of herbicide application.
Do the infestation levels decrease?	Annually	Survey the cleared areas and record species, densities and size. Before and after pictures are very effective.	If the infestation levels are not decreasing, reconsider clearing intervals and look at clearing methods. If infestation levels are decreasing - continue clearing, you are doing well!
How much herbicides were used?	During every operation (If WFW provides the herbicides, a landowner agreement will be signed and the records are to be submitted to WFW)	Keep track of cost and ensure no wastage. Record herbicide usage	Track usage over time, it will reveal a certain trend in quantities for different infestation levels. Less herbicides should be used when the infestation levels are lower. Record herbicide cost.
Does the indigenous vegetation recover in the cleared areas?	Annually	Survey the cleared areas and look out for indigenous species variety and presence. Before and after pictures are very effective.	If it does – you are doing well, if not, look at clearing methods, clearing intervals or consult an expert
How many jobs were created?	After every operation	Timesheets	Job creation figures are useful when asking for landowner assistance from WFW or to demonstrate contributions to jobs and socio-economic conditions
How many person days (PD) were spent per operations?	After every operation	Timesheets	Keep track of cost and assist with planning and budgeting. Determine cost per person day (PD)

11 CONTROL METHODS

Following best practice as described in this document, will ensure compliance with NEMBA Section 75 (1) (2) & (3) in that the means and methods of control are appropriate to the species and environment and are implemented in such a way that it minimizes the risk to biodiversity and the environment:

- Control actions must be taken with care to ensure the least possible harm to biodiversity and the environment (take care not to remove sensitive indigenous species or damage them for example by using the incorrect herbicide application; or bulldozing).
- Offspring, propagating material and regrowth of invasive species should be tackled to prevent these species from producing offspring, forming seed, regenerate or re-establish.
- Implement measures to prevent the starting of wildfires, including the spreading of fires to neighbouring land, and be ready to combat fires on the farm should they occur.
- Mechanical equipment and hand tools must be best suited to the work and the size of plants being cleared and in a good working condition.

11.1 Initial clearing

- Equipment required: Chainsaws, loppers, bow saw, 2ℓ handheld herbicide cans.

11.2 Follow up clearing

- Conduct follow up within six months after initial clearing, before plants have the opportunity to produce seeds.

11.3 Mechanical & manual control methods

- Fell trees with a stem diameter of > 200mm with a chainsaw
- Cut trees with a stem diameter of < 200mm with a bow saw or silky saw
- Cut trees and plants with a stem diameter of < 100mm with a lopper
- Cut as low as possible above ground level, ideally 10 cm or below the last growth point.
- Ensure even cuts
- Seedlings can be hand-pulled in sandy soil, important to uproot the entire plant, breaking off will cause it to regrow.
- Mechanical equipment for the control and removal of vegetation. Mechanical machinery can be used out outside of the sensitive, wetland area.

11.4 Herbicide application

Ensure herbicide applicators are appropriately skilled.

- Wear correct personal protective equipment (PPE)
- Only apply registered herbicides at prescribed rates, follow label instructions

11.5 Cut stump treatment:

- Use spray can (2ℓ spraymaker) for smaller plants and knapsack for larger trees and apply herbicides to the stump immediately after cutting or felling.
- For larger stumps, only apply herbicides to the outer 50mm (cambium) (Figure 4).
- Minimize collateral damage by applying herbicides using the correct nozzle and pressure.

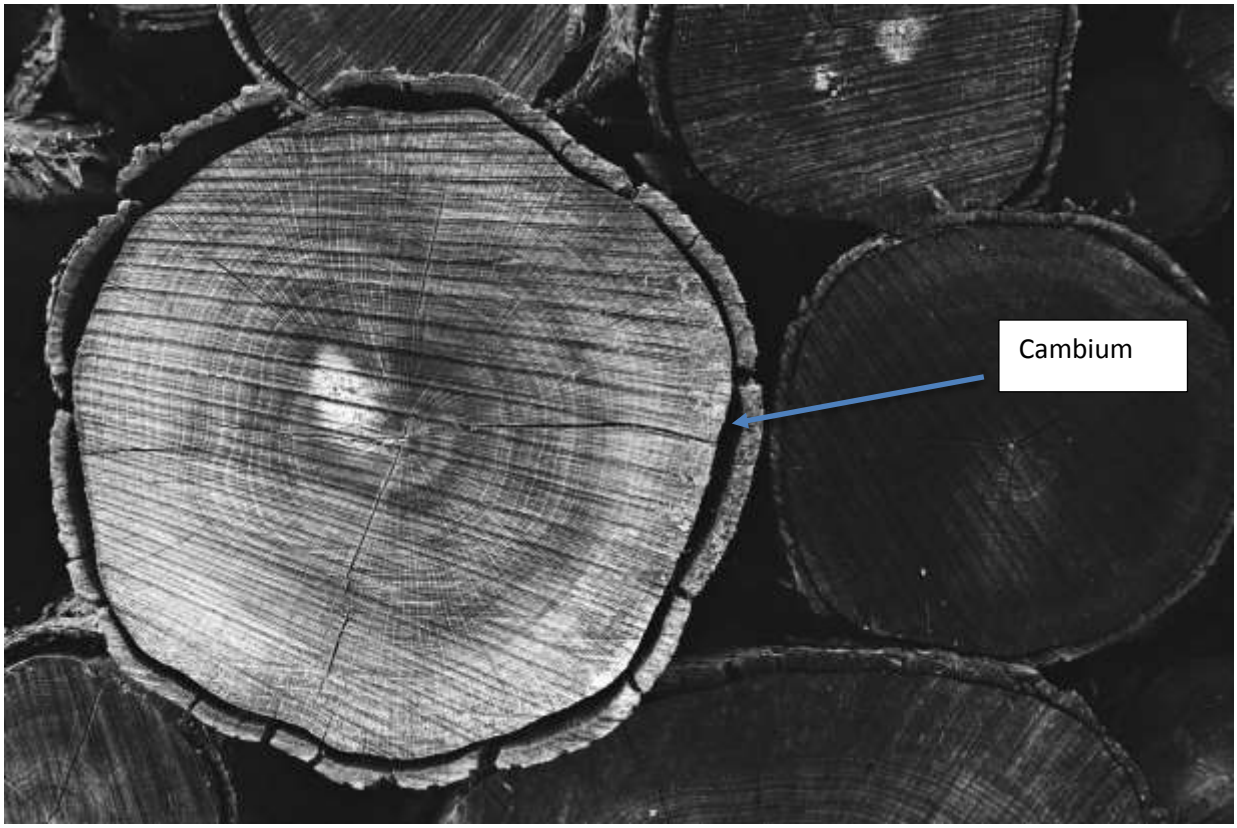


Figure 4: Indicating the cambium layer of a tree trunk

11.6 Foliage treatment

Suitable for plants up to 1m tall. Use a knapsack sprayer with a pressure regulator to evenly apply herbicides at the required mixture (Figure 5).

Figure 5: Example of foliar spraying (Picture by L. Merle)

11.7 Precautions during herbicide application:

The risk of herbicide drift exists especially in the vicinity of watercourses. Apply only under suitable weather conditions, at appropriate rates by appropriately qualified herbicide applicators. Treatment is least effective in very hot weather or when the plants are water stressed. Do not apply herbicides during windy conditions to prevent herbicide drift and damaging non-target plans.

Complete herbicide control sheet to maintain usage records (Table 12).

Table 12: Example of Herbicide control sheet that should be used.

Herbicide Control Sheet							
Site name: Libradene						**Hectares: 22.34**	
Day	**Herbicide (name)**	**Herbicide (name)**	**Herbicide (name)**	**Herbicide (name)**	**Herbicide (name)**	**Actipron**	**Dye**
1							
2							
etc							

12 SAFETY, HEALTH AND ENVIRONMENT (SHE)

It is the landowner's responsibility to ensure a safe working environment and that the teams working on the property adhere to the minimum safety requirements. This can be achieved by sourcing appropriately trained and experienced teams. The principle of "leave no trace" applies.

The landowner should liaise with the contractor to ensure the following minimum SHE requirements are adhered to:

12.1 Toilet facilities

- The contractor is responsible for providing a mobile toilet on site for the duration of the work (it is not in all cases possible to provide a mobile toilet, where the field conditions are not suitable for a mobile toilet, human waste should be buried by digging a hole of at least 20 cm deep)
- Clean water must be made available in suitable containers for drinking and mixing herbicides

12.2 Team's skills requirements

- Chainsaw operators in possession of valid certificates
- Herbicide applicators certified

12.3 Work methods and equipment

- Equipment must be suitable for the work and in good working condition
- Adhere to work methods stipulated in the site specification

12.4 Vehicle and driver

- The driver must be in possession of a valid PrDP
- The vehicle must be roadworthy
- Tools must be transported in the trailer, separately from the workers

12.5 Safety precautions

- Certified SHE Rep on site
- Certified Safety Office on site
- The SHE Rep must conduct daily safety talks
- The first aid kit must be on site

12.6 COID (Compensation for Occupational Injuries and Diseases)

- The contractor must be in possession and present proof of a valid certificate of good standing with the Compensation Commissioner

- Any incidents must be reported to the landowner
- An indemnity form must be signed stating that the contractors excepts full liability for any COID related matters and that the landowner will not be held liable should the contractor not comply with minimum standards
- The contractor deals with COID cases and not the landowner
- Near misses, incidents and accident register must be kept

12.7 Insurance

- The contractor must be appropriately insured for the vehicle and equipment
- The contractor must provide proof of third party and liability insurance
- Sign an agreement whereby the contractor accepts liability for damages in case of negligence

12.8 Storage of fuel and herbicides

- Fuel and herbicides must be left in a shady area, away from the resting/eating area
- The area must be clearly marked with bunting
- The bunting must be removed on completion of the job
- Herbicide mixing and refuelling must be conducted on a spill blanket
- A spade must be on site to cover any accidental spillage
- A serviced and functional fire extinguisher must be kept at the fuel refilling area

12.9 Preventing fires

- No smoking while working, assign a designated smoking area
- Remove cigarette butts
- No smoking during windy conditions
- Keep 1 fire beater for every team member within reach of the workers
- No chainsaw work during Code Red days - Fire Danger Indices (FDIs) obtainable from FPA

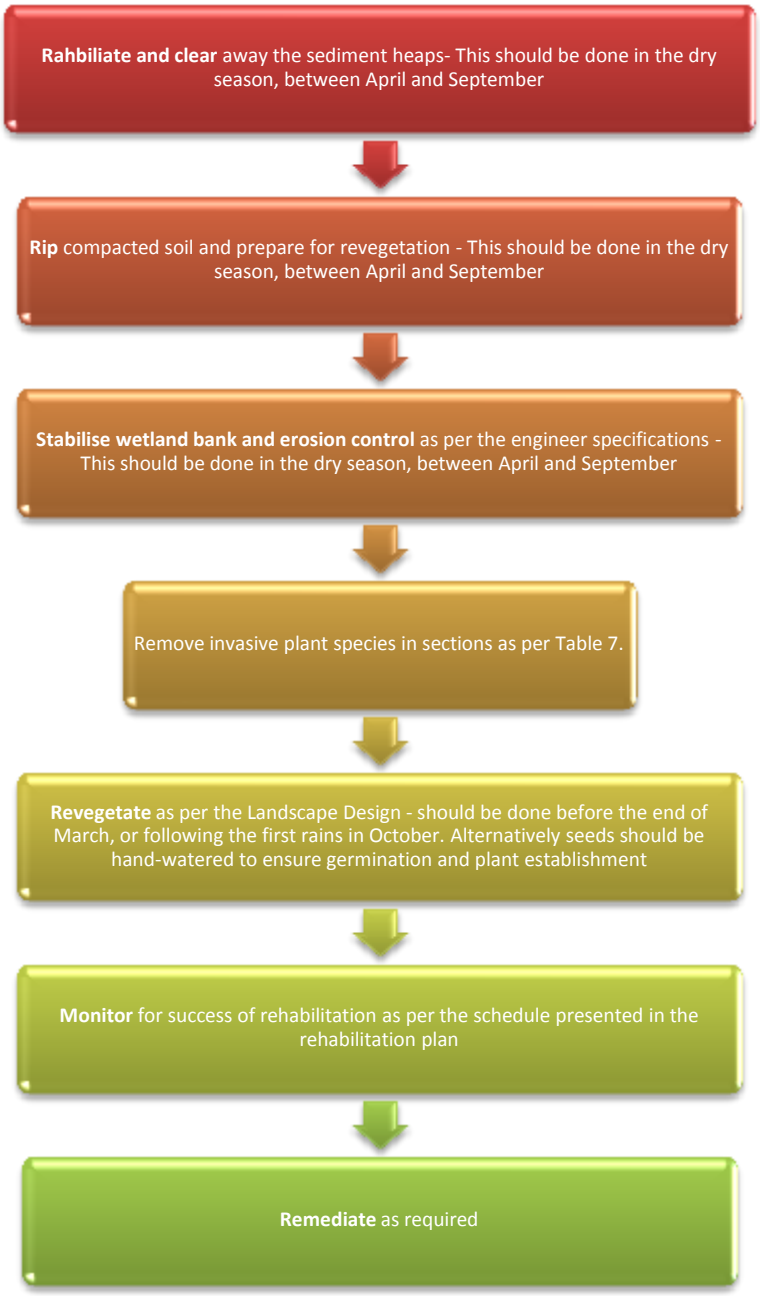
12.10 Correct (Personal Protective Equipment) PPE should be worn at all times (Table 13)

Table 13: Correct PPE clothing that should be worn

Item	Supervisor	Machine operator	General workers SHE Rep; 1st Aid Rep; Driver	Specialized herbicide applicator
Sunhat (follow up operations)	✓	✓	✓	✓
Hard hat (when chainsaws are being used)	✓	✓	✓	✓
Hard hat with visor and certified earmuffs (SABS or EU),	x	✓	x	x
T-shirt	✓	✓	✓	✓
Conti suit	✓	✓	✓	✓
FESA approved chainsaw pants (eleven layers) with broad belt or braces	x	✓	x	x
Whistle	✓	✓	x	x
Safety boots	✓	✓	✓	✓
Gumboots (only when working in riverine/wetland areas)	✓	✓	✓	✓
Chainsaw safety boots	x	✓	x	x
Gloves	✓	✓	✓	✓
Chainsaw operators gloves	x	✓	x	x
Safety goggles	✓	✓	✓	✓
Cape (when using a knapsack)	x	x	x	✓
Mask (when applying herbicides)	x	x	x	✓
Rubber gloves (for mixing herbicides)	x	x	x	✓
Rubber apron (for mixing herbicides)	x	x	x	✓
Rain suit (during rainy conditions)	✓	✓	✓	✓

13 CONCLUSION

The following process flowchart provides a summary of rehabilitation actions, together with the sequence in which they should be conducted.



14 REFERENCES

Department of Water Affairs and Forestry, (2005): Environmental Best Practice Specifications: Construction for Construction Sites, Infrastructure Upgrades and Maintenance Works. Version 3

Department of Water Affairs (2010): National Water Act, 1998 (Act No 36 of 1998) S21(c) & (i) Water Uses. Version: February 2010. Training Manual.

Kotze D C, (1999): A system for supporting wetland management decisions. Ph.D. thesis. School of Applied Environmental Sciences, University of Natal, Pietermaritzburg.

Limosella, 2020. Orlando Dam upgrade, Johannesburg, Gauteng Province: General Rehabilitation and Monitoring Report. Submitted to Envirolution Consulting

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 Department of Water Affairs. Pretoria

Marneweck G C, and Batchelor A L, (2002). Wetland classification, mapping and inventory. In: PALMER R W, TURPIE J, MARNEWECK G C, and BATCHELOR A L. Ecological and economic evaluation of wetlands in the upper Olifants River Catchment, South Africa. WRC Report No. 1162/1/02. Water Research Commission, Pretoria