WETLAND REHABILITATION PLAN FOR THE PROPOSED HELMSLEY AGRICULTURAL ESTATE, PORTION 177 (OF 161) OF THE FARM COMPENSATION NO. 868, KWAZULU NATAL

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Disclaimer

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1. Introduction

1.1. Background

Enviroswift KZN has been appointed by IDM Consultants to develop a Wetland Rehabilitation Plan for the upgrade of an access road into the proposed Helmsley Agricultural Estate (hereafter referred to as 'the access road'). The access road is located on Portion 177 of 161 of the Farm Compensation No 868 FU within the KwaDukuza Municipality, KwaZulu Natal, and provides access into the property from District Road D176.

At present the existing ±4m wide gravel access road traverses three valley bottom wetlands (watercourse 7b, 8 and 9) (Figure 1). Pipe culverts have been developed below the road in order to allow through flow. However, these culverts are narrow and do not allow sufficient dispersion of flow beneath the road. The growth of sugarcane and the build-up of debris at the entrance and exit of the pipe culverts has also resulted in the disruption of flows through the wetlands.

The upgrade of the existing access road will include the ripping up of the existing gravel road and the construction of a new tarred road which will be approximately 10m wide. Watercourse crossings will be constructed from rectangular portal stormwater culverts laid on dump rock to allow water seepage below the road. These culverts will cater for a storm interval of 1:2 years as specified by the SANRAL Road Drainage Manual for tertiary roads. During larger rainfall events the culverts will overtop and concrete slab and concrete guide blocks will therefore be constructed. Detailed road design drawings are provided in Appendix 1.

The three wetlands which will be traversed are located within the boundary of the proposed agricultural estate and it is the intention of the proponent to rehabilitate and landscape the features in their entirety in order to improve their aesthetic value.

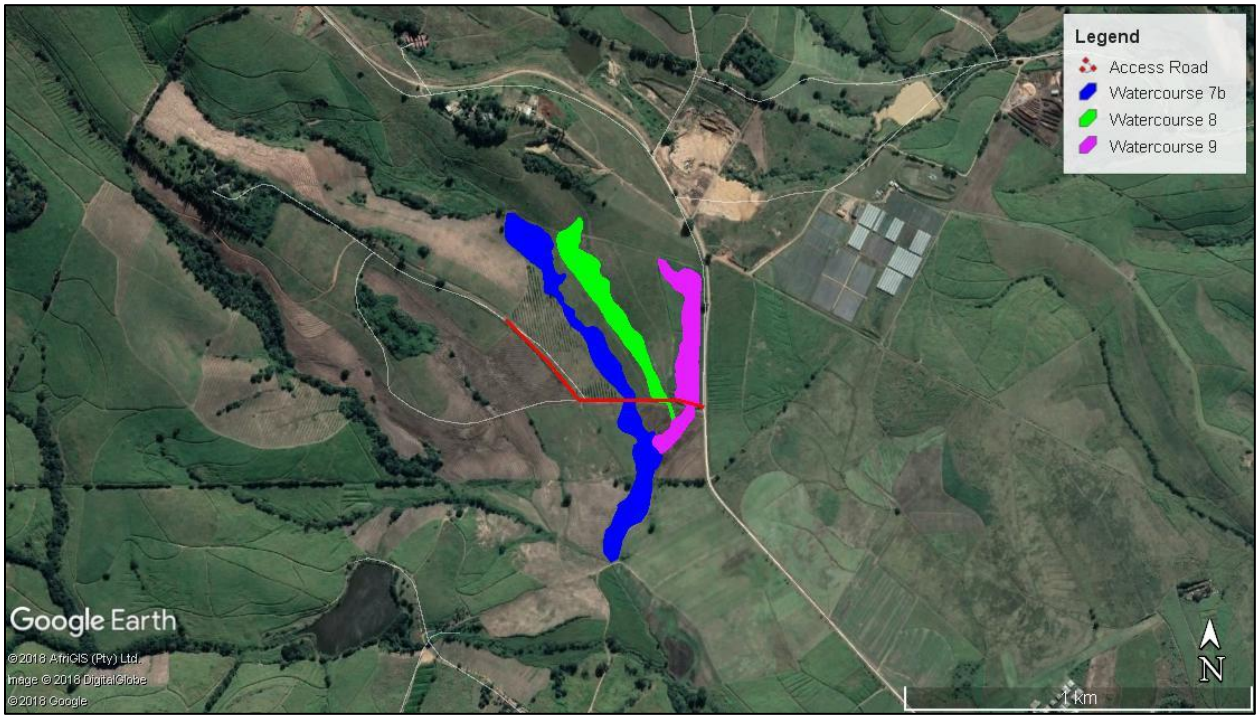

Figure 1: The access road and watercourses 7b, 8 and 9 in relation to surrounding areas (Google Earth Pro, 2018).

1.2. Scope of Work

The scope of work included the following:

- Develop a Rehabilitation Plan to manage impacts associated with the upgrade of the access road on wetland features indicated in Figure 1;
- Description of required management and monitoring objectives; and
- Determination of wetland hectare equivalents pre and post rehabilitation.

1.3. Assumptions and Limitations

The final boundary of the proposed road upgrade was not available at the time of the compilation of this report. However, it was confirmed with the appointed engineers (BIGEN) that the new road and all associated infrastructure will not exceed 10m in width. The precautionary principal was therefore applied and the calculation of the total area of wetland habitat which will be lost as a result of road upgrade activities has been based on the maximum total width of the upgraded road.

During the calculation of the post rehabilitation Present Ecological State (PES) of wetland features it has been assumed that all rehabilitation and monitoring/management measures as specified within this report have been successfully implemented.

Due to the naturally dynamic nature of wetland systems it was not possible to say with 100% certainty what the characteristics of the wetlands will be post-rehabilitation. The precautionary principal was therefore applied when calculating the approximate post-rehabilitation PES of wetland features.

2. Watercourse Description

Three wetlands, watercourse 7b, 8 and 9 will be impacted on as a result of the proposed upgrade of the access road (EnviroSwift KZN, 2017).

Watercourse 7b, 8 and 9 are characteristic of channelled valley bottom wetlands. These wetlands have been significantly degraded as a result of the past and present cultivation of sugarcane within the features and as a result of the excavation of desiccation channels and drains within the feature in an attempt to dry the wetland areas out. This disturbance has resulted in the loss of natural wetland vegetation and in the proliferation of alien and invasive species such as *Coix lacryma-jobi*, *Solanum mauritianum, Bidens pilosa, Ageratum conyzoides, Conyza sp., Hibiscus diversifolius* (Swamp hibiscus)*, Pennisetum purpureum* and *Paspalum dilatatum* (Dallasgrass). However, more common hydrophylic species such as *Phragmites australis* (Common Reed)*, Leersia hexandra* (Swamp Rice Grass), *Pycreus polystachyos* and *Cyperus* spp were also encountered within the wetland. The historical development of the access road through the features has also resulted in the disruption of flow through the wetlands.

The WET-Health tool[1] was utilised to assess the PES of the wetlands. The overall wetland health[2] scores calculated for all of the wetlands within their present states fall within Category E (seriously modified - The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable) (EnviroSwift KZN, 2017).

The WET-EcoServices[3] tool was utilised to assess wetland services and functions provided by the features. The wetlands were determined to be of increased importance in terms of Increased importance in terms of phosphate, nitrate and toxicant assimilation and in terms of erosion control (EnviroSwift KZN, 2017).

[1] Macfarlane *et. al.* 2010
[2] (hydrology score) x 3 + (geomorphology score) x 2 + (vegetation score) x 2 / 7 = overall wetland health
[3] Kotze *et al*., 2007

The Ecological Importance and Sensitivity (EIS) of each of the wetlands was calculated and it was determined that watercourse 7b is of a moderate EIS while watercourse 8 and 9 are of a low EIS.

Figure 2: Representative photographs of watercourse 7b.

Figure 3: Representative photographs of watercourse 8.

Figure 4: Representative photographs of watercourse 9.

3. Vision and Objectives

3.1. Vision

The vision of the Wetland Rehabilitation Plan is to:

- Mitigate negative impacts associated with the construction and operational phases of the road development; and
- Improve the PES and function of the wetlands which will be impacted on by the upgrade of the access road.

3.2. Objectives

The main objectives of the Wetland Rehabilitation Plan are to:

- Prevent unnecessary disturbance of wetland habitat;
- Remove alien vegetation and sugarcane from wetland areas;
- Deactivate desiccation channels and drains;
- Improve hydrology of wetland areas;
- Restore wetland vegetation;
- Improve the PES of wetland habitat; and
- Improve the function of wetland habitat.

The measures required to obtain these objectives are listed in Section 5 of this report.

4 Impacts

During the development of the rehabilitation plan, the **existing** impacts to the watercourses as well as the impacts as a result of development related activities had to be considered. The existing as well as potential impacts that may result due to the upgrade of the access road are listed in the sections to follow.

4.1. Existing Impacts

Key existing impacts identified included:

- Increased abstraction of water by Macadamia plantations in the catchment of watercourse 7b and sugarcane within the catchment of all features has likely reduced flows into the features;
- An increase in bare, disturbed soils within the catchment of all features as a result of agricultural activities has resulted in a small increase in floodpeaks. The runoff of sediment with stormwater from bare and disturbed areas has also resulted in the sedimentation of the wetlands;
- Watercourses 7b and 8 were historically cultivated with sugarcane. At present the wetlands are characterised by secondary vegetation and are dominated by ruderal and alien and invasive species;
- Watercourse 9 is currently cultivated with sugarcane;
- Desiccation drains and channels within the wetlands have resulted in an impact to the distribution and retention of interflow; and
- An existing gravel access road traverses the wetland features. Pipe culverts have been developed below the road in order to allow through flow. However, these culverts are narrow and do not allow sufficient dispersion of flow beneath the road. The growth of sugarcane and the build-up of debris at the entrance and exit of the pipe culverts has also resulted in the disruption of flows through the culverts.

Figure 5: Existing access road traversing the wetlands (left) and disturbed, alien infested vegetation associated with wetland crossing areas (right).

Figure 6: Plant material and debris blocking culverts associated with watercourse 7b (photograph a), watercourse 8 (photograph b) and watercourse 9 (photograph c).

4.2. Potential Impacts During the Construction Phase

As part of the identification of potential freshwater impacts, it has been assumed that the specific conditions as set by the Record of Decision (RoD, 2008, amended 2017) will be strictly adhered to, and that all management measures as stipulated within the Environmental Management Plan (EMP) (compiled by IDM Environmental, 2012) and the stormwater management plan[4] (compiled by BIGEN Africa, 2007) will be implemented.

Specific conditions set within the RoD[5] make reference to:

- Wetland management:
  - All agricultural crops must be removed from wetland areas and planted outside the 20m buffer from the edge of the temporary wetland areas[6];
  - No development, including infrastructure may occur within 20m from the edge of the delineated temporary wetlands; and
  - Delineated wetland areas must be managed for conservation as part of the residential estates open space system.
- Sewage and solid waste disposal including recommendations relating to:
  - The management of the package plant;
  - The disposal of sludge and waste material;
  - The use of wastewater for irrigation purposes; and
  - Water quality monitoring.
- Dust control;
- Stormwater management and soil erosion including recommendations relating to:
  - The stormwater management plan for the development;
  - Alien vegetation control;
  - Drainage control; and
  - Soil erosion prevention.

Management measures stipulated within the EMP (IDM Environmental, 2012)[7] include measures addressing:

- Construction site: set up and facilities;
- Protection of wetlands;
- Erosion, sedimentation and stormwater control;
- Material handling and storage;
- Vehicle and equipment refuelling;
- Waste management and disposal;
- Contaminated water;
- Accidental leaks and spills; and
- Site cleanup and rehabilitation.

Should the above conditions be strictly adhered to and should the management measures be implemented, the majority of the freshwater impacts associated with the proposed development related activities will be prevented. However, the following impacts are still likely to occur regardless of the adherence to the conditions and management measures:

[4] Please refer to the Stormwater Management report for a detailed description of management measures.
[5] Please refer to the RoD (2008, amended 2017) for a detailed description of the specific conditions.
[6] Assumed that reference to wetlands within the Environmental Authorisation includes rivers and riparian areas.
[7] Please refer to the EMP for a detailed description of management measures.

Key impacts as a result of construction related activities:

- Loss and disturbance of wetland habitat associated with watercourses 7b, 8 and 9:
  - The upgrade and widening of the existing gravel access road will result in the loss of approximately 629m^2 of significantly degraded wetland habitat;
  - The development of a construction working servitude will result in the temporary disturbance of wetland habitat;
  - The proposed upgrade of the access road and the construction of stormwater culverts will result in the disturbance of wetland areas directly adjacent to the upgrade activities; and
  - The rehabilitation of wetlands will result in the temporary disturbance of wetland habitat.

- Water Quality Impairment:
  - Construction vehicles will need to traverse watercourses 7b, 8 and 9 on the existing gravel access road in order to gain access to the project footprint, and the upgrading of the gravel access road will require the use of construction equipment within the watercourses. This increases the potential of the contamination of surface water within the watercourses as a result of leaks or spillages from construction vehicles and equipment; and
  - An additional threat is considered to be the pollution of surface water with cement and other construction related materials during the upgrading of the gravel access road and associated culverts.

- Hydrological Regime Alteration:
  - The upgrading of the access road and culverts below the road may result in an impact on the flow patterns through the watercourses due to the diversion or obstruction of flow during construction activities.

4.3. Potential Impacts During the Operational Phase

Key impacts as a result of operational related activities:

- Further disturbance of wetland habitat associated with the watercourses 7b, 8 and 9:
  - Specific conditions set within the RoD which make specific reference to erosion control and alien vegetation control will be implemented. Further disturbance to the features as a result of alien proliferation or erosion and sedimentation is therefore not anticipated.

- Hydrological regime alteration:
  - Existing narrow pipe culverts currently obstruct flow through the wetland features. The upgrade of these culvert structures will ultimately result in an improvement of flow through the wetlands and will therefore result in a positive operational phase impact; and
  - The accumulation of debris within culverts below the road may result in the restriction of flows through the features during the operational phase should the debris not be removed, which would result in upstream ponding.

5. Rehabilitation and Management Measures

5.1. Pre-construction/Design/Construction Related Management Measures

In order to ensure that post-construction rehabilitation is successful, it is important to manage pre-construction/design/construction related impacts. Additional management measures to those provided within the RoD and the EMPR are listed within the sections to follow.

5.1.1. General Management Measures

The following general management measures must be implemented in order to avoid disturbance of wetland habitat:

- The Environmental Control Officer (ECO) must ensure that the contractor and all subcontractors are aware of their roles and responsibilities;
- Restrict access road upgrade activities to the dry winter months;
- Construction camps, storage areas, soil stockpile areas and laydown areas must be located at least 20m away from the edge of all delineated watercourses;
- Restrict disturbance of wetland soils to a narrow construction working servitude adjacent to the existing gravel access road. The construction working servitude must be as narrow as practically possible and must be demarcated and cordoned off. Areas outside of the demarcated area must be designated as no-go areas;
- The ECO must oversee the immediate rehabilitation of any accidental disturbance to habitat falling outside of the demarcated construction footprint area. Disturbed/compacted areas must be ripped and revegetated according to the re-instatement of vegetation measures as listed for the rehabilitation phase below;
- Prohibit the dumping of spoil material within surrounding wetland areas. Spoil material must be appropriately disposed of at a registered waste disposal facility;
- Any topsoil and indigenous vegetation removed from the direct construction footprint must be stored at the designated stockpile area for use in future rehabilitation activities;
- Cleared vegetation and soils which will not be utilised for rehabilitation purposes must be disposed of at a registered waste disposal facility; and
- Once construction has been completed all construction waste, rubble, and equipment must be removed from the study area.

5.1.2. Soil Management Including Erosion and Sedimentation Control

The following soil management measures must be implemented in order to prevent erosion and sedimentation of wetland habitat:

- Limit construction activities to the dry winter months in order to reduce erosion and sedimentation as a result of stormwater runoff;
- Implement erosion control measures (e.g. covering disturbed, bare areas with geotextiles, straw bales, brush packing, mulch etc.) in order to prevent the erosion and sedimentation of wetland areas. Erosion control measures must be implemented with guidance from the ECO;
- Install silt fences/traps downstream of the road crossing area during construction activities to trap any sediment produced during construction activities. The ECO must be consulted on the location of silt fences, and silt fences must not result in any unnecessary disturbance to the watercourses.
- Remove sediment from silt fences/traps on a regular basis, at least once a week;
- The ECO/contractor must ensure silt fences / traps are adequately maintained;

- The contractor/ECO must check the site and wetlands for erosion damage and sedimentation after every heavy rainfall event and on the completion of construction. Should erosion or sedimentation be noted the damage must be rehabilitated immediately under the guidance of the ECO. Rehabilitation measures may include the filling of erosion gullies and rills and the stabilization of gullies with silt fences;
- Divert stormwater runoff and sheet runoff away from areas susceptible to erosion;
- Topsoil and subsoil removed during construction must be stockpiled separately at designated stockpile areas for future rehabilitation activities;
- Stockpiles must be located in a stockpile area at least 20m away from the edge of all delineated watercourses;
- Stockpiles must be stabilised with geotextiles in order to prevent erosion;
- Soil stockpiles must be kept free of weeds and should be kept damp in order to avoid wind-blown sand;
- Topsoil should not be stockpiled for more than 6 months. If stockpiled for more than 6 months the topsoil must be enriched prior to rehabilitation; and
- Cleared vegetation and soils which will not be utilised for rehabilitation purposes must be disposed of at a registered waste disposal facility.

5.1.3. Alien Vegetation Control

The following measures must be implemented in order to control the proliferation of alien and invasive vegetation:

- The construction site and surroundings must be checked by the ECO for alien and invasive species on the completion of construction and alien species noted must be removed. Refer to Appendix 2 for alien vegetation control measures;
- The use of herbicides should be avoided. However, if necessary, only herbicides which have been certified safe for use in wetlands/aquatic environments by an independent testing authority may be considered. The ECO must be consulted in this regard;
- Dispose of removed alien plant material at a registered waste disposal site or burn on a bunded surface where no stormwater runoff is expected;
- Remove vegetation before seed is set and released; and
- Cover removed alien plant material properly when transported, to prevent it from being blown from vehicles.

5.1.4. Prevention of Water Quality Impairment.

The following measures must be implemented in order to prevent water quality impairment:

- The contractor must inspect heavy machinery daily for leaks;
- Servicing of vehicles and refuelling should preferably take place off site. However, if this is not possible, use bunded surfaces within designated areas at least 20m away from the edge of all delineated watercourses for servicing and re-fuelling vehicles;
- Store fuel, chemicals and other hazardous substances in suitable secure weather-proof containers and within an area with impermeable and bunded floors at least 20m away from the edge of all delineated watercourses;
- Prohibit the washing of vehicles or machinery in watercourses or their buffer areas; and
- The contractor is responsible for cleaning up any spillages (e.g. concrete, oil, fuel), immediately and must remove contaminated soil and dispose of it appropriately.

5.1.5. Prevention of Hydrological Alterations

The following measures must be implemented in order to prevent alterations to the hydrological regime of wetlands:

- Ensure that hydrological connectivity between areas upstream and downstream of the access road is maintained throughout the construction phase;
- The culvert design must allow for sufficient dispersion of water through the valley bottom wetlands to prevent the concentration of flow and the resultant scouring and incision of the channels of the features;
- Ensure that the beds of the features at the road crossing area are restored to the natural base level in order to prevent erosion or upstream ponding (i.e. the base of culverts must tie in with the natural base level of the wetlands); and
- Should the culverts not span the entire width of the wetlands, the pioneer layer of the portions of the road which travers wetland areas should be constructed out of a porous material or from a material which is coarse enough to allow the movement of water below the road to downstream areas.

5.2. Post-construction/Rehabilitation/Operational Phase Related Rehabilitation Measures

In order to improve the PES and function of watercourses 7b, 8 and 9 during the operational phase, rehabilitation measures must be implemented. Rehabilitation measures associated with the post-construction/rehabilitation/operational phase of the development are listed below:

5.2.1. Rehabilitation of Disturbance Caused as a Result of the Upgrade of the Access Road:

The following rehabilitation measures must be implemented in wetland areas disturbed as a result of the upgrade of the access road:

- Rip and loosen compacted soils within the construction working servitude within wetlands to a depth of 300mm in order to aid in the establishment of vegetation;
- Reshape and reprofile the wetland areas to either side of the road so that they tie in with the surrounding wetland areas both longitudinally and perpendicularly (height, slope and structure);
- Redistribute stockpiled topsoil across the wetlands;
- Implement erosion control measures within newly worked, bare areas in order to prevent the loss of topsoil due to wind and water erosion. These areas may be covered with geotextiles such as Biojute (this is of particular importance in areas with a steeper slope) or may be stabilized with the use of sediment fences;
- Do not remove temporary erosion protection materials until the vegetation cover has re-established; and
- Revegetate disturbed wetland areas utilising the revegetation methodology as listed in Section 5.2.3.4 below.

5.2.2. Rehabilitation of Wetland Buffer Areas:

The following rehabilitation measures must be implemented within wetland buffer areas:

- Rehabilitate and stabilise the buffer areas of wetlands prior to the rehabilitation of wetland areas. This will help to reduce the erosion and sedimentation of wetland habitat due to an increase in runoff:
- Remove sugarcane and alien species from the buffer areas of watercourses 7b, 8 and 9. Refer to Appendix 2 for alien vegetation control measures;
- Deactivate desiccation drains within the buffers. This can be achieved through backfilling the channels and drains with *in situ* material. Additional material may need to be imported from an approved location if sufficient material is not available *in situ;*
- Rip soils in buffers to a depth of 500mm in order to aid in the removal of remaining sugarcane ratoons and to ensure that soils are not compacted. Any existing gravel access roads running through buffer areas must also be ripped;
- Reshape and reprofile buffer areas in order to achieve a more natural topography;
- Seed terrestrial buffer areas with indigenous tufted graminoid species with a high basal cover which will reduce the velocity and volume of runoff from hardened surfaces in the catchment before it reaches the wetland areas. Examples of indigenous graminoid species which may be utilised include:
    - *Aristida junciformis*
    - *Themeda triandra;*
    - *Melinis repens;*
    - *Melinis nerviglumis;*
    - *Brachiaria serrata;* and
    - *Tristachya leucothrix*.
- Seed the ecotone on the boundary of the terrestrial buffer and wetland with graminoid species which are also able to withstand high moisture levels for limited periods. Examples of such species include:
    - *Eragrostis capensis;*
    - *Eragrostis racemose;*
    - *Imperata cylindrica;*
    - *Andropogon appendiculatus;* and
    - *Setaria sphacelata.*
- It is recommended that broadcast seeding or hydroseeding is utilized;
- Should broadcast seeding be utilised, it is recommended that weed free straw or mulch is applied immediately after applying the seed, at a rate of approximately 4 tons per hectare, in order to assist in the germination and establishment of seedlings; and
- <u>Revegetation of buffer areas, including floral species selection and the most appropriate seeding technique must be overseen by a suitably qualified landscaper or rehabilitation specialist.</u>

5.2.3. Rehabilitation of Wetlands

5.2.3.1. General

The following general wetland rehabilitation measures must be followed:

- Rehabilitation of wetland habitat must be undertaken in a phased approach so as to minimise the duration of time that any one portion of wetland is left bare and at risk of erosion[8]. It is recommended that not more than 1ha of wetland habitat is rehabilitated at a time;
- The implementation of rehabilitation measures must follow the order in which they are listed in the sections to follow; and
- Rehabilitation should start at the head of the wetland and work its way downslope so as to avoid the sedimentation and disturbance of already rehabilitated downslope wetland areas as a result of runoff.

5.2.3.2. Removal of Alien Vegetation

The following alien vegetation control measures must be implemented:

- Remove alien vegetation and sugarcane from the wetland areas; and
- Refer to Appendix 2 for alien vegetation control measures.

5.2.3.3. Reinstatement of the Natural Topography and Hydrology of Wetland Areas.

The following measures must be implemented in order to reinstate the natural topography and hydrology of wetland features:

- Deactivate desiccation drains and central channels running through wetlands (Figure 7). This can be achieved through backfilling the channels and drains with *in situ* material and will ensure that water is spread across the valley bottom wetlands and that a more natural hydrological regime is reinstated. Additional material may need to be imported from an approved location if insufficient material is available *in situ;*
- Prior to backfilling, suitable wetland vegetation should be dug up in sods. Sods can be planted in plastic bags for temporary storage and must be watered daily. Sods must be replanted as soon as possible after backfilling is completed, preferably within 1 to 2 weeks after they have been removed;
- It is imperative that the reinstatement of a more natural hydrological regime is achieved prior to revegetation, as the wetland species assemblages which will be used to revegetate the wetland areas are dependent on the hydrological regime of the wetlands;
- Rip and loosen compacted soils to a depth of 300mm in order to aid in the establishment of vegetation;
- Reshape and reprofile the wetlands in order to achieve a natural topography;
- Redistribute stockpiled topsoil across the wetlands;
- Implement erosion control measures within newly worked, bare areas in order to prevent the loss of topsoil due to wind and water erosion. These areas may be covered with geotextils such as Biojute (this is of particular importance in areas with a steeper slope) or may be stabilized with the use of sediment fences; and
- Do not remove temporary erosion protection materials until the vegetation cover has re-established.

[8] A phased approach, in which removal of invasive species is undertaken concurrently with reshaping. reprofiling and re-seeding/replanting of cleared areas with indigenous species.

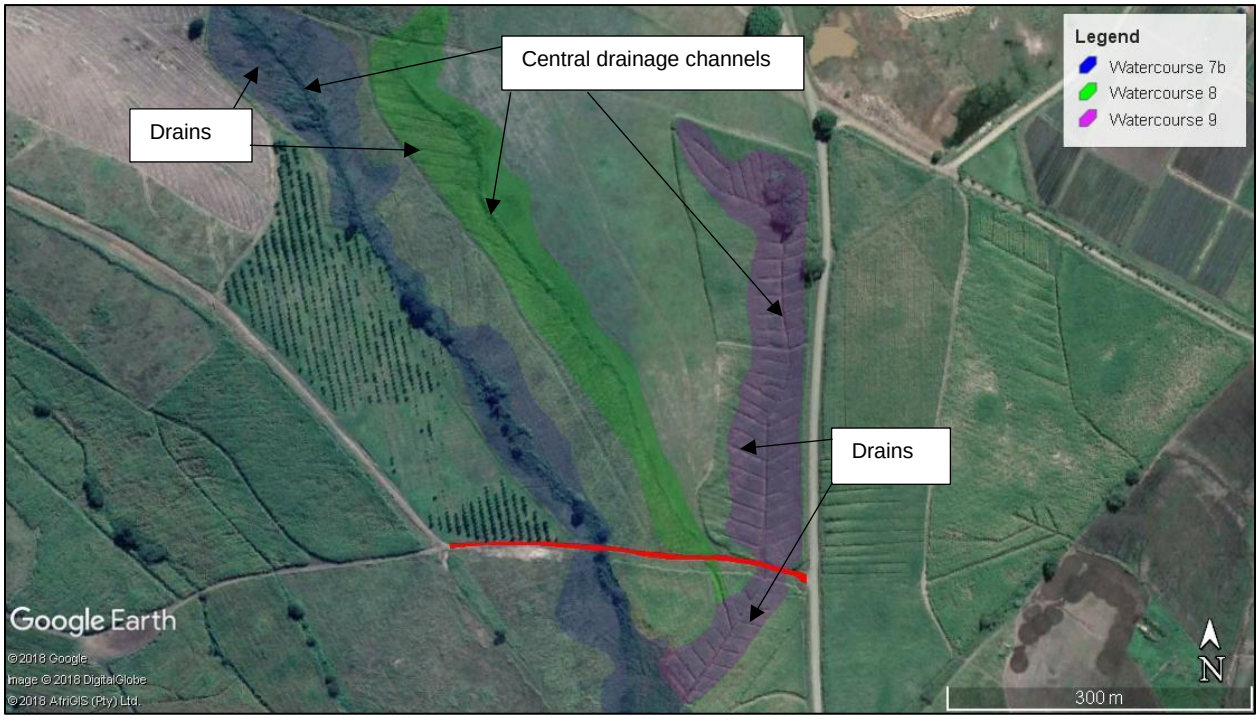

Figure 7: Examples of desiccation channels and drains to be backfilled.

5.2.3.4. Revegetation of Wetland Areas.

The following revegetation methods must be applied:

- Revegetate the wetlands with the indigenous wetland species as listed below as soon as possible after the application of topsoil and stabilizing of soils;
- Plugs may be obtained from adjacent habitats of similar plant composition. However, if plugs are sourced from adjacent habitat, care must be taken so as not to result in the excessive disturbance of the surrounding areas. An ECO must oversee the removal of plugs from adjacent areas;
- Additional wetland plants required for rehabilitation purposes must be sourced from a local nursery which breeds plants from the region;
- Wetlands can be subdivided into permanent, seasonal and temporary zones of wetness, and different wetland species are adapted to these varying degrees of wetness. A map has been provided below indicating the estimated extent of the various zones of wetness for each applicable wetland[9]. Examples of indigenous graminoid and sedge species which may be utilised during revegetation as well as the wetness zone in which they should be planted is provided below:
    - Permanent Zone:
        - *Cyperus latifolius;*
        - *Cyperus dives;*
        - *Cyperus solidus;*
        - *Juncus lomatophyllus;* and
        - *Phragmites australis;*
    - Seasonal Zone
        - *Bulbostylis hispidula;*
        - *Cyperus dives;*
        - *Cyperus laevigatus;*
        - *Cyperus sexangularis;*

[9] It is important to note that wetness zones indicated are a rough guideline and may change after the implementation of rehabilitation measures.

    - *Cyperus solidus;*
    - *Cyperus sphaerospermus;*
    - *Juncus dregeanus;* and
    - *Pycreus nitidus.*
  - Temporary Zone
    - *Aristida junciformis;*
    - *Andropogon appendiculatus;*
    - *Bulbostylis hispidula;*
    - *Cyperus congestus;*
    - *Cyperus sphaerospermus;*
    - *Imperata cylindrica;* and
    - *Setaria sphacelata.*
- It is recommended that the temporary areas of wetlands are broadcast seeded or hydroseeded with the grass species as listed above[10] and that individuals of sedges are planted in amongst the seeded areas;
- Should broadcast seeding be utilised, it is recommended that weed free straw or mulch is applied immediately after applying the seed, at a rate of approximately 4 tons per hectare, in order to assist in the germination and establishment of seedlings;
- Water plants immediately after they are planted and regularly[11] for the first week to aid in establishment;
- Revegetation must take place in winter (between June and August). This will allow the plants to establish before flood events. Regular[12] watering of revegetated areas may be required prior to spring rainfall; and
- <u>Revegetation, including floral species selection and positioning as well as planting method, must be overseen by a suitably qualified landscaper or rehabilitation specialist.</u>

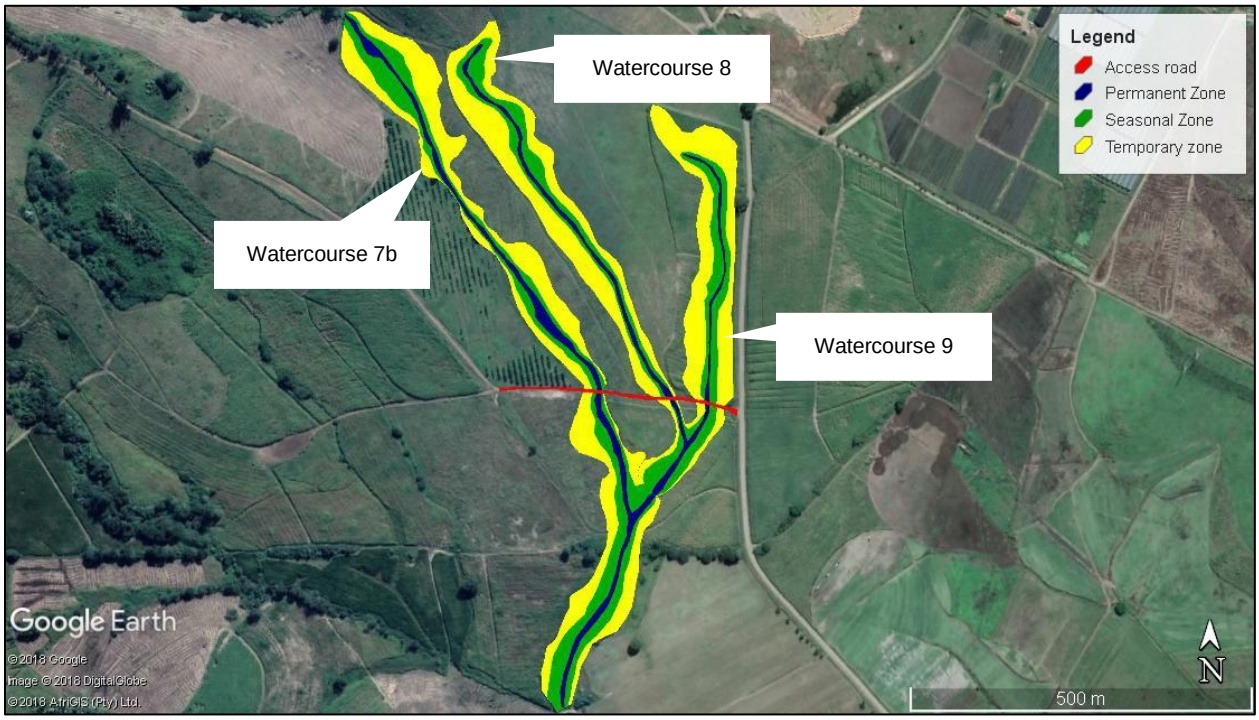

Figure 8: Estimated zones of wetness associated with each of the watercourses.

[10] *Aristida junciformis, Andropogon appendiculatus, Imperata cylindrica* and *Setaria sphacelata.*
[11] Dependent on rainfall. Must be determined by a suitably qualified ECO or landscaper.
[12] Dependent on rainfall. Must be determined by a suitably qualified ECO or landscaper.

6. Monitoring Measures

Monitoring of watercourses must be undertaken during all phases of the development in order to ensure that the management and rehabilitation measures as in the sections above are implemented and that development related activities do not result in a permanent adverse effect to watercourses. Monitoring activities undertaken during the post-construction, rehabilitation and operational phases of the development will ensure that areas disturbed during the construction phase have been adequately rehabilitated and stabilised and that development activities do not result in a long term impact to watercourses.

Monitoring requirements for each phase of the development have been listed in the table to follow.

Table 1: Monitoring requirements and responsible parties.

Phase	Monitoring requirement	Responsible party
Pre-construction/ Design	• Fixed point photography must be undertaken before construction commences in order to establish the baseline condition of the watercourses which will be affected. Photographs must be taken of wetland habitat occurring both up and downstream of the proposed access road upgrade. • Fixed points should be permanently marked and GPS co-ordinates should be recorded for each site. This is to ensure that points can be relocated. • Develop photo record forms for each photo which include information such as the project name, location, unique identity number, directional point (e.g. North, South), date, time, photographers name and additional comments. • When photos are taken, additional qualitative ecological information must be recorded. This information may include: o Evidence of erosion, sedimentation and incision. o Vegetation condition. o Extent of alien invasive plants. o Extent of vegetation ground cover. o General level of plant growth. o General observations of water levels, water quality such as clarity and presence of litter. o Faunal species encountered. o Evidence of anthropogenic activities and dumping.	Suitably qualified, independent ECO
Construction	• Monitoring audits and reporting should be undertaken every week during construction by the ECO. • A photographic record must be kept of all incidents/accidents and any non-compliance encountered. • The following impacts must be recorded by the ECO and must be immediately rehabilitated by the contractor under the supervision of the ECO: o Destruction or disturbance of habitat outside of the demarcated construction working servitude. o Erosion and sedimentation of wetland habitat. o Water quality impairment as a result of leaks, spills, littering. o Increased stormwater runoff from disturbed areas.	Suitably qualified, independent ECO and contractor

	○ Disturbance of soil stockpiles and loss of soils as a result of erosion by wind and water. • Fixed point photography must be undertaken once a month at areas selected during the pre-construction phase in order to establish the impact to wetlands as a result of construction.	
Post-Construction/ Rehabilitation/ Operational phase	**<u>Monitoring of revegetation</u>** • Fixed point photography must be undertaken every month during revegetation and every month after revegetation is complete until vegetation has successfully established (i.e.>90% indigenous vegetation cover). This is useful to monitor the changes to wetland habitat. • The ECO/appointed landscaper must also conduct weekly site visits after revegetation is complete in order to address any revegetation concerns. If revegetation of an area is unsuccessful the area should be ripped to a depth of 300mm and revegetated according to the measures as listed within section 5.2.3.4. • Once re-vegetation is successful it must be signed off by the ECO. **<u>Monitoring of alien vegetation</u>** • The ECO/appointed landscaper must conduct weekly site visits to remove any re-emergent alien plants from wetland areas and buffers (preferably by hand pulling). Any areas of soil disturbed during the removal of alien vegetation must be reseeded with an indigenous grass mix in order to prevent the re-establishment of alien vegetation. • Alien and invasive species clearing must be undertaken by the body which resides over the estate quarterly (once every three months) for the life of the development (preferably by hand pulling or uprooting). Any areas of soil disturbed during the removal of alien vegetation must be reseeded with an indigenous grass mix in order to prevent the re-establishment of alien vegetation. **<u>Monitoring of erosion and sedimentation</u>** • The ECO/appointed landscaper should monitor the wetland areas every month for the first 12 months in order to ensure that excessive erosion and sedimentation of the wetland habitat is not occurring as a result of the access road upgrade. • Should erosion and sedimentation be noted, eroded areas must be rehabilitated and management measures must be put in place immediately in order to prevent further damage to the wetlands. • Thereafter, the wetlands must be monitored bi-annually/after heavy flood events by the body that preside over the administration of the proposed estate in order to ensure that erosion and sedimentation are not taking place. **<u>Monitoring of culverts over wetlands</u>** • Culverts below the access road must be checked by the body which resides over the estate bi-annually as well as after heavy rainfall events in order to ensure that they remain free of debris and that flow through the wetlands is not obstructed.	Suitably qualified landscaper/ ECO and the body which resides over the estate.

7. Present Ecological State After Proposed Rehabilitation Activities

A WET-Health assessment was undertaken for watercourse 7b, 8 and 9 prior to development (EnviroSwift KZN, 2017). The results of this assessment were then compared to a WET-Health assessment undertaken for each of the wetlands presuming that the rehabilitation measures as listed above were successful (Tables 4, 5 and 6).

The proposed upgrade of the access road will result in the loss of approximately 235m^2 degraded wetland habitat from watercourse 7b, approximately 188m^2 degraded wetland habitat from watercourse 8 and approximately 206m^2 degraded wetland habitat from watercourse 9. However, the upgrade of culverts below the existing road will improve flow through the features and will therefore improve the hydrological integrity of the features. Furthermore, the backfilling of drains and channels, the removal of sugarcane and alien vegetation, and the revegetation of the features with indigenous wetland vegetation will improve the overall hydrological, geomorphological and vegetation integrity of the features as well as the overall function and service provision of the features.

Based on the current PES score for watercourse 7b, the approximately 6.08ha of wetland habitat is currently equivalent to 2.21ha intact wetland habitat. However, for the post-development/post-rehabilitation scenario the wetland habitat will be considered to be equivalent to 4.46ha intact wetland habitat. There is therefore a gain of approximately 2.24 hectare equivalents.

Table 2: Ecological integrity and hectare equivalents of watercourse 7b for the pre-development and post development scenario

Watercourse 7b		
	Pre-development	Post-development/Post-rehabilitation
Overall impact score	6.36	2.64
Overall PES category	E	C
Hectares of wetland	6.0796	6.0561
Hectare equivalents	2.2129	4.4573

Based on the current PES score for watercourse 8, the approximately 3.13ha of wetland habitat is currently equivalent to 0.79ha intact wetland habitat. However, for the post-development/post-rehabilitation scenario the wetland habitat will be considered to be equivalent to 2.25ha intact wetland habitat. There is therefore a gain of approximately 1.46 hectare equivalents.

Table 3: Ecological integrity and hectare equivalents of watercourse 8 for the pre-development and post development scenario

Watercourse 8		
	Pre-development	Post-development/Post-rehabilitation
Overall impact score	7.48	2.76
Overall PES category	E	C
Hectares of wetland	3.1340	3.1152
Hectare equivalents	0.7898	2.2554

Based on the current PES score for watercourse 9, the approximately 3.23ha of wetland habitat is currently equivalent to 0.67ha intact wetland habitat. However, for the post-development/post-rehabilitation scenario the wetland habitat will be considered to be equivalent to 2.33ha intact wetland habitat. There is therefore a gain of approximately 1.66 hectare equivalents.

Table 4: Ecological integrity and hectare equivalents of watercourse 9 for the pre-development and post development scenario

Watercourse 9		
	Pre-development	Post-development/Post-rehabilitation
Overall impact score	7.94	2.76
Overall PES category	E	C
Hectares of wetland	3.2349	3.2143
Hectare equivalents	0.6664	2.3271

7. Conclusion

The upgrade of the existing gravel access road into the proposed Helmsley Agricultural Estate will result in the limited loss of already significantly degraded wetland habitat from watercourse 7b, 8 and 9. However, the upgrade of culverts below the road and the successful implementation of the wetland rehabilitation and management plan is likely to result in an overall improvement in the hydrological, geomorphological and vegetation health of the wetlands and will ultimately result in an overall gain in wetland hectare equivalents.

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Working for Water Species Herbicide List V2.9

APPENDIX 1: PROPOSED ACCESS ROAD DESIGN DRAWINGS

APPENDIX 2: ALIEN VEGETATION CONTROL

1. Alien Vegetation Control: Methods

Various methods are available for the control of alien and invasive species. Some of these methods are discussed in detail below[13].

1.1. Hand Pulling

Hand pulling is the removal of plants by hand, ensuring that the root is also removed. Hand pulling is only recommended when an area is sparsely invaded, has a high rainfall (the soil should ideally be damp or soft), warm temperatures, and sandy soils; and the plants are small enough to be pulled out successfully with the roots intact. Hand pulling does create soil disturbance, but if the area is sparsely invaded such disturbances are unlikely to be ecologically damaging.

1.2. Manual Removal Using Hand Tools

Manual removal using hand tools such as cane knives, tree loppers and slashers can be used to remove alien and invasive species. The use of hand tools is probably the most widely adopted, and often the most effective, of all the methods. Methods of cutting the plants include:

1.2.1 Ring-barking

Useful for killing large trees. A cane knife or axe is used to remove the tree's bark and cambium, in a horizontal band about 30cm wide (about 50cm from the ground). Herbicide, if used, should be applied immediately after ring-barking on the cut area.

1.2.2 Cut-stumping

Plants with a stem/trunk diameter larger than 10mm can be cut as low to the ground as possible with a saw or cane knife. Herbicide, if used, should be applied to the cut surface immediately after cutting.

1.2.3 Slashing

The seed stalks/branches of annuals (plants that die each year after they set seed) can be slashed with a cane knife, mattock, bill hook or slasher before the seeds have matured. This is an effective method significantly reducing the presence of viable seeds that will germinate in the new season. Costs are generally low for controlling annuals in this way, as no herbicide is required.

1.2.4 Strip-barking

With the use of a cane knife or axe, the bark of large trees can be stripped completely, from waist height down to the base of the trunk. Herbicide, if used, should be applied to the stripped surface immediately after strip-barking. This is an effective but time-consuming method.

[13] Extracted from the Guideline Document - General Invasive Alien Plant Control: Insight into Best Practice, Removal Methods, Training & Equipment, produced by the eThekwini Municipality's Environmental Planning and Climate Protection Department

1.2.5 Frilling

Small trees can be frilled by cutting an angled groove into the bark and cambium, right the way around the tree trunk. This can be achieved with either a cane knife or axe, depending on how hard the bark and cambium layers of the tree are. Herbicide is then applied into the groove, which kills the tree as it seeps into the cambium tissue. This is the preferred method of killing small trees, as it is usually much quicker and therefore more cost-effective than ring-barking or strip-barking.

1.3. Manual removal using mechanised tools

A variety of mechanised tools can be used for alien and invasive species clearing. They include:

1.3.1 Brush-cutter

Heavy duty motorized brush-cutters that are usually powered by a small two-stroke engine are popular for controlling low-growing thickets of alien and invasive species (e.g. bramble). Importantly, a suitable blade must be fitted to the brush-cutter, for example, fitting a steel blade will allow for cutting of stems that are up to 15cm in diameter. Use of the standard nylon cutting head for plants such as Montanoa, results in excess vibration to the drive shaft and bearings which leads to excessive gearbox wear. Overloading the machine in this way soon leads to gear or bearing failure or a reduced life of certain other moving parts. The expenses that result from ongoing repair costs are obvious. Ideally, herbicide application to the cut stems should follow immediately after cutting. A team effort can work well in such instances, with one or two team members each applying herbicide as they follow in the path of the machine operator. Stems with a diameter smaller than 10mm are easy to miss, hence the advantage of having several herbicide applicators.

1.3.2 Chainsaw

A chainsaw is ideal for felling large trees and can be used to cut logs and branches into shorter lengths. This allows ground crew members to move the logs more easily, or load them onto a vehicle if they are to be carted away. Common target species for felling include large specimens of Syringa, Pine, Gum and Wattle. Training for chainsaw operators is essential. Operators need to understand the techniques of felling, i.e. ensuring that the tree falls in the desired direction. Each operator must also understand and be able to apply the necessary safety precautions during the felling process. Understanding the effective use and operation of the chainsaw itself is critical. The operator should also have the means and knowledge to undertake any required onsite servicing of the motor and sharpening of the chain. It is advisable that no other persons be working in close proximity to where a tree is being felled.

1.4. Chemical Control

Chemical control of alien and invasive species involves the use of herbicides (plant poison) to kill targeted plants. Managers and herbicide operators must have a basic understanding of how herbicides function, as this will guide the correct selection of herbicides for different purposes and plants. The use of inappropriate herbicides and the incorrect use of the appropriate herbicides are wasteful, expensive practices. They often do more harm than good. This is especially problematic when working in close proximity to watercourses. Some herbicides can quickly contaminate fresh water systems and/or be transported downstream where they may remain active in the ecosystem. This is especially the case for herbicides with a high soil residual effect, i.e. herbicides that remain active after contact with soil.

Herbicides are classified as either selective or non-selective. Selective herbicides are usually specific to a particular group of plants, e.g. those specified for use on broad leaf plants will be effective on most broad leaf plants, but should not kill narrow leaved species such as grasses. Non-selective herbicides can kill any plant they come into contact with, and are therefore not suitable for use in areas where indigenous plants are present.

1.4.1 Chemical Application Training

More information on training is available online at www.invasives.org.za. Alternatively, contact the Project Manager of WESSA Stop the Spread on 031 266 2603 or at stopthespread@wessakzn.org.za.

1.4.2 Chemical Application Techniques

Chemical application techniques include foliar (leaf) application, stem applications (basal stem, total frill, stem injection) and stump applications (cut stump, total stump, scrape and paint):

1.4.2.1 Foliar spraying

This method uses a knapsack sprayer to spray alien and invasive species below 1 metre in height. Leaves are sprayed to the point of run-off. Correct training and certification is essential before a team member uses this method. It is advisable to invest in good quality knapsack sprayers and ensure replacement parts can be purchased. Regular servicing and cleaning of working parts is critical, as leaking sprayers can result in herbicide seeping onto workers, or onto the ground and thereby impacting on indigenous vegetation. Foliar spraying is generally regarded as a cheaper method than cut stump treatment, because fewer people are required to treat larger areas. It does, however, require large amounts of clean water (for mixing with herbicides), and therefore only practical where water is available. Protective gear must be used at all times and the Guidelines provided in this handbook for mixing and storing of herbicides must be adhered to. Herbicide applicators should have completed a certified training course. Alternately, contractors with four or more years of experience can be nominated for a certificate if they receive a letter from a Registered Pest Control Operator that states the nature and duration of their relevant experience. Herbicide applicators need to understand the implications of splash and drift. When a plant is sprayed with herbicide, it is almost certain that excess herbicide will leave the target area. This might not be problematic in areas of high-density infestations: excess herbicide will either drift or drip onto other target alien and invasive species, it is however problematic when there are many non-target species close by. The misting effect, where tiny droplets drift *via* a breeze to non-target species, often occurs when using high velocity nozzles. Ideally, low velocity and high volume nozzles should be used for drenching, while high velocity, low volume nozzles should be used for misting.

1.4.2.2 Handheld spraying

Handheld spraying is a means to apply herbicide after cut stumping, ring-barking, frilling and strip-barking. The most common and convenient handheld sprayer has a 1.5 litre capacity and a nozzle that can be set to achieve the correct spray width. As with knapsack sprayers, it is advisable to invest in a good quality handheld sprayer for which replacement parts can easily be purchased. Always ensure workers receive training on how to maintain handheld sprayers properly. Handheld sprayers are cheap, and application of herbicide is accurate.

2 Site Specific Alien Vegetation Control Measures.

For alien vegetation control and removal it is recommended that a suitably qualified contractor is utilised who employs people that already know which species are alien and require removal and management.

Hand pulling and manual removal using hand tools are the preferred methods for alien vegetation control for this project, however, herbicides may also be used in cases where dense infestations are present or where cut stumps need treatment. Only herbicides which have been certified safe for use in wetlands/aquatic environments by an independent testing authority may be considered. The contractor must be consulted in this regard. Herbicides should not be applied as a foliar spray as drift may cause surrounding indigenous plants to be impacted upon. Plants should rather be cut and the remaining stumps treated using a stem painting technique. The herbicide should be applied directly after the stem of the plant is cut. Therefore, a small area must be selected in which all stems are cut and treated prior to the selection of a new area. Non-selective herbicides such as Roundup, Chopper and Mamba must not be utilised during alien control operations as these herbicides kill both trees and grass species. Furthermore, any herbicide which needs to be mixed with diesel must not be utilized as it will pose a risk to water quality within the wetland areas.

Alien vegetation clearing must be undertaken in a stepwise manner and plants should be removed from a single area at a time. All alien plant material which is removed must be disposed of at a registered waste disposal site or burned on a bunded surface where no stormwater runoff is expected; Species specific control measures for some of the alien species identified on site are listed in the table to follow:

Table A: Some of the alien and invasive species identified on site and their applicable control methods.

Alien species	Size class	Control Method	Examples of herbicides which may be utilized[14]
Solanum mauritianum	Seedlings and young plants	Hand pull or uproot (preferred)	N/A
	Adult	Cut at ground level and treat stump	Timbrel (WfW Species Herbicide List V2.9).
Pennisetum purpureum	All sizes	Hand pull (preferred)	N/A
Coix lacryma-jobi	Seedlings and young plants	Hand pulled or uprooted	N/A
	Adult	Hand pull/uproot or removed by mechanical means	N/A
Bidens pillosa	All sizes	Hand pull / uproot	N/A
Conyza sp.	All sizes	Hand pull / uproot	N/A
Chromolaena odorata	Seedling	Hand pull	N/A
	Young	Hand pull (preferred) or cut at ground level and treat stump	Timbrel (WfW Species Herbicide List V2.9).
	Adult	Cut at ground level and treat stump	Timbrel (WfW Species Herbicide List V2.9).
Verbena bonariensis	All sizes	Hand pull / uproot.	N/A
Tagetes minuta	All sizes	Hand pull / uproot	N/A
Ageratum conyzoides	All sizes	Hand pull / uproot	N/A

[14] It is important that a suitably qualified contractor is consulted in order to confirm the most appropriate herbicide for use in wetland habitats. The incorrect use of herbicides will result in an impact to wetland areas.

Ageratum conyzoides	All sizes	Hand pull / uproot	N/A
Tecoma stans	Seedling and young	Hand pull / uproot	N/A
	Adult	N/A	N/A
Ipomoea purpurea	All sizes	Hand pull / uproot	N/A
Lantana camara	All sizes	Hand pull / uproot or remove by mechanical means.	N/A
Canna indica	All sizes	Hand pull / uproot	N/A
Ludwigia peruviana	All sizes	Hand pull / uproot	N/A
Melia azadarach	Seedling	Hand pull	N/A
	Young	Cut at ground level and treat stump	Timbrel (WfW Species Herbicide List V2.9).
	Adult	Cut stump / frill	Timbrel (WfW Species Herbicide List V2.9).

For additional information about the use of herbicides contact The Plant Protection Research Institute, Cedara:
Tel: 033-355 9416 or 033-355 9413
Email: ntjg@natal1.agric.zaAlso
http://www.nda.agric.za

To find professional Contractors who remove alien plants contact:

The Botanical Society – KZN Coastal Branch
Fax: 031 - 201 9958
Email: plantnet@iafrica.com

The Wildlife and Environment Society of SA (WESSA)– KZN Region
Tel: 031-201 3126
Email: wlskzn@saol.com

Natural Areas Section, Durban Parks Department
Tel: 031-312 4466
Email: KateE@prscu.durban.gov.za