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FRESHWATER SPECIALIST REHABILITATION, MAINTENANCE AND MANAGEMENT ACTIONS REQUIRED FOR THE REMOVAL OF REED SPECIES AND REVEGETATION OF THE VARIOUS DAMS WITHIN THE PEARL VALLEY GOLF ESTATE, SOUTHERN PAARL, WESTERN CAPE PROVINCE.

1. INTRODUCTION

Freshwater Ecologist Network (FEN) Consulting (Pty) Ltd was appointed in February 2022 to assist with freshwater specialist inputs as part of the Maintenance and Management Plan (MMP) compiled by Guillaume Nel Environmental Consultants (GNEC, 2022)[1]. As such the contents of this report must be read in conjunction with the relevant MMP compiled by GNEC (2022).

This memorandum is prepared specifically for works to be undertaken in the various dams located within the Pearl Valley Golf Estate, off the R301 in southern Paarl, Western Cape (hereafter referred to as the study area) (**Appendix A: Figure 1**). The study area has twelve (12) dams which are all considered off-stream dams, none of which are located within any watercourses, and all have been licenced for storage and/or aesthetics by the Department of Water and Sanitation (DWS) and store a combination of pumped Berg River water and groundwater (Water Use Licence (WUL) number 20/G10C/AB/4712 dated the 8th of July 2016). The dams have been referenced 1 – 12 for ease of reference (**Appendix A: Figure 2**). Most of the storage dams are interconnected via artificial channels that were excavated as part of the dam network to allow stormwater and overflow water to moved between dams and once full capacity has been reached, water is released via a channel to the north (into the Val de Vie Phase II development) where it is a hydrological driver of a Channelled Valley Bottom (CVB) wetland system. Although these artificial channels are not considered to be watercourses due to their artificial nature, they are important in the landscape for hydrological connectivity to other downstream watercourses and thus require maintenance throughout their life. Since no dams are located within any watercourses nor are the artificial channels considered to be watercourses, no authorisation in terms of the National Water Act, 1998 (Act No. 36 of 1998) is required for any proposed maintenance works within these systems.

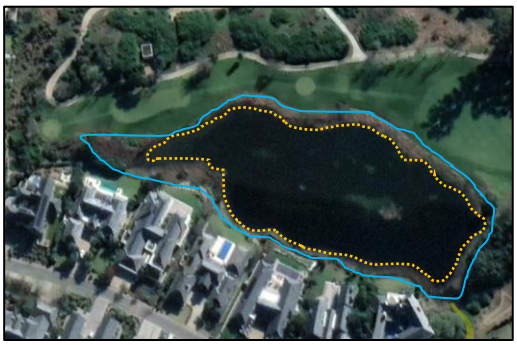
[1] *GNEC. January 2022. Maintenance and Management Plan: pearl Valley Residential Estate, Paarl, Western Cape.*

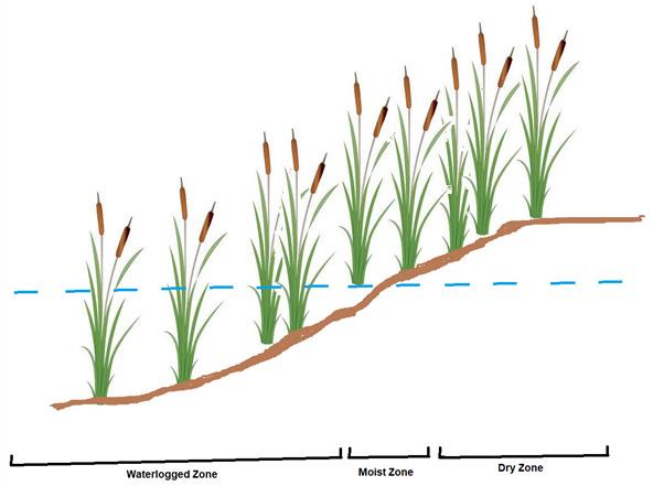
2. SITE SPECIFIC MAINTENANCE AND MANAGEMENT REQUIREMENTS

This freshwater MMP will consider the maintenance requirements, specifically with regards to the management of alien and encroacher vegetation species (with specific mention of *Typha capensis* reeds and *Cyperus papyrus* sedges which need to be controlled in order to limit their infestation) within the dams and associated artificial channels. The following table provides key mitigation measures that must be implemented as part of the proposed maintenance activities.

It must be noted: it is not recommended to remove all invaded vegetation at once, and to still retain a buffer zone of vegetation along the dam edge as the dense vegetation stands does provide habitat for a variety of avifaunal species. Similarly, it must be assured that when vegetation removal is considered, it takes cognisance of the breeding season of these avifaunal species to ensure minimal disruption.

Table 1: Activities and rehabilitation measures applicable to the dams and artificial channels.

Activity	Mitigation Measures
Control of *Typha capensis* within the various dams and channels.	 *Typha capensis* is a phenologically adaptable "opportunist" species (although not considered an AIP) that can become an aggressive encroacher of disturbed systems, specifically within areas of elevated nitrogen availability, such as the dams within the Pearl Valley Golf Estate. The species is adapted to increased water depths and extended hydroperiods resulting in dense monotypic stands which outcompete other species.    **Figure 1: Two of the identified areas where reeds need to be removed (Top left: Dam 2 and right: Dam 12). Blue line indicates the outer edge of the dam, orange dashed line indicates current open water. Area between the two lines require vegetation removal. (bottom) examples of *Typha capensis and Cyperus spp* within an artificial channel.** Controlling excessive *Typha capensis* growth is extremely difficult and can be quite costly, particularly in natural systems. Various methods have been tried and tested all over the world, but there is no easy way to control the plant as such a multiple method approach is noted to be the best. Three different control methods are discussed: 1. Mechanical removal

Activity	Mitigation Measures
	Mechanical removal is difficult because of the depth and volume of the rhizomes, but it can be effective in reducing the size of infestations. Manual removal works best on small seedlings when they can be easily pulled out of the damp soil. The best way to control larger *Typha capensis* is through utilisation of controlled burning (although this might not be feasible in the Pearl Valley Golf Estate setting) and physical cutting at the end of the growing season (when the highest level of nutrients in the shoots towards the end of the productive (growing) period in the late summer period, i.e. during February) and when water levels are lowest in the associated dams in conjunction with flooding. Cutting must be undertaken to maximise nutrient depletion by removal of above-ground biomass prior to the translocation of nutrients from shoots to rhizomes, which occurs in late summer (February) but must be done before seeds/flowers blow over the area. If the reeds are burnt and/or cut when water levels are low, and then flooded, growth is considerably inhibited but NOT stopped. Two clippings about a week or two apart will achieve best results but then the cut area must be submerged as soon after in at least 8 to 10 cm of water when water levels rise again. Using fire will help a great deal, but there are inherent dangers that must be considered, specifically to the surrounding residential areas. (Initial cut treatment involves the classification of three different management zones associated with the dams/channels (Figure 2): ➢ The 'dry zone', located furthest from the dam edge and with surface soil (top 20 cm) not waterlogged; ➢ The 'moist zone', situated between the dry zone and dam edge with waterlogged surface soil but no free-standing water, and ➢ The 'wet zone', within the dam with soil covered in free standing water. It must be noted that the wet zone is not always static due to fluctuations of the water level (due to seasonality, stormwater influx control etc.).  **Figure 2: Different management zones identified within the dams.** The following method statement for mechanical reed cutting is described below: ➢ Dedicated access paths must be marked (the entrance to these access paths indicated by a flag and pole or something similar) to allow workers to access the reed beds at specific points only and to avoid trampling of other (indigenous) vegetation species and disturbing potential nesting avifauna; ➢ Use can also be made of small boats to access the waterlogged zones; ➢ Reed shoots must be cut at ground level across the three zones identified (Figure 2), and thus below water in the wet zone. This can either be done with the use of: o Rotary brush cutter, mechanical reed cutter or chainsaws or sickles must be used, as no heavy machinery within the dams should may be permitted as this could result in additional sediment and turbidity of the dams (small four stroke motorised boats may be permitted); or

Activity	Mitigation Measures
	○ An aquatic mower[2], which is an underwater reciprocating mower that mounts to a small boat or a hand saw can be used to cut reeds below the water level. ➢ A small barge (shoal-draft flat-bottomed boat) can be made use of to transport the cut reeds from the waterlogged zone to the shore or a wheelbarrow can be used (in the dry zone); ➢ Cut reeds must be stockpiled in a designated area to allow the reeds to dry out and be compacted for eventual transport, outside the dams for composting/burning. It must be noted that cutting of the reeds will remove a large volume of surface biomass, but regeneration of the reeds may occur immediately thereafter. From other studies undertaken in various natural watercourses throughout the Western Cape, it is apparent that once-off cutting without inundation (moist zone and dry zone) may be largely ineffective as a means to control *T. capensis* encroachment, whereas the extent of inundation (wet zone) significantly influences reed regrowth in cut areas. Despite double cutting in the dry and moist zones causing a reduction in shoot size and increase in shoot density, when compared to once-off cutting, it was observed that the effects of cutting were not amplified with successive cuts. Thus, reed coppicing is likely to be very limited in inundated areas, but will occur along the embankments of the dam, in the moist and dry zones. It is recognised that cutting may only be a short-term solution which will need to be implemented every year to achieve long-term success, or the cut treatment can be followed by the application of an authorised herbicide. 2. <u>Control of rhizomes and sediment</u> Should rhizome and sediment below the cut sites require removal, the following is recommended: ➢ Only sediment from the specific cut site and that in the dry and moist zones (Figure 2) may be removed up to a depth of 30 cm. This is to avoid sediment plumes from occurring in the water column and prevent the smothering of biota (including macrophytes, invertebrates and fish that are within the dams). In this regard the following must be adhered to: ○ Minimise the number of people operating within the cut site and the number of trips to and from the cut site – this will limit the concentrations of suspended sediment in the water; ○ Minimise collateral suspension by using selected entry and exit points to the cut sites (use only those originally earmarked for use during reed cutting); ➢ A 'Mud and muck shovel[3]' can be used to dig out the sediment. This specific shovel allows for water to drain out of the collected sediment before it being placed in a wheelbarrow for transportation. Additionally, this shovel also collects any cut reed and rhizome debris. Alternatively, a normal shovel can be used to dig out the sediment. For removing saturated sediments, a normal shovel can be used to remove the sediment, where after the sediment can be placed over perforated material (such as shade cloth) which may act as a sieve to allow water to pass through and sediment to remain, this can be transported to the designated stockpiling area via a wheelbarrow. It is important to minimise collateral suspension by using selected entry and exit points to the cut sites (use only those originally earmarked for use during reed cutting) and prevent excessive turbidity within the dams. The removed materials (cut reeds, rhizomes and sediment) may not be left to decompose within the dams (which may result in further eutrophication), within close proximity to its embankment or within any nearby open public spaces, as this may cause a nuisance to the surrounding residential developments. The cut reeds, rhizomes and seeds may not be composted on site near any watercourses or dams as seeds and rhizomes can survive and grow in a compost heap, creating a new stand or dispersing via wind (seeds) to other areas. As such, the material should preferably be burnt within seven (7) days of being cut/removed. 3. <u>Herbicide application as follow up treatment (not preferred)</u>

[2] Available for purchase online at https://weedrazers.com/product/aquatic-mower-2695-00/

[3] A 'Mud and Muck shovel' is a shovel are specifically designed to facilitate the removal of sediment from a body of water in a simple and non-technical way. This shovel has a perforated shovel head (small holes punched through the shovel's bowl). These holes are small enough that they allow water and air to pass through, leaving nothing but the sediment behind in the shovel and allowing the user to scoop the shovel through the sediment without having to deal with the suction that would ordinarily be created by mud and deep sediments. Available for purchase online at https://jonesfish.com/products/muck-shovel-1

Activity	Mitigation Measures
	Herbicides can be effective when applied while the plant is flowering, but the disadvantage is that the decaying plant material accumulates and results in hypertrophic conditions, this plant material also provides a good substrate for regrowth of *T capensis*. Some herbicides may also have negative effects on other plant and animal life within the dams. There are two herbicides, Glyphosate and Triclopyr that are commercially available and known to control *T. capensis* effectively when used properly. Commercially available herbicides containing glyphosate includes Roundup and Mamba 360 SL which are systemic foliar applied herbicides. Glyphosate is nonselective and will enter any plant species (targeted and non-target plant species) through contact with the leaves or stems and be translocated to the rhizomes. It must, however, be noted that Glysophate will not kill seeds or inhibit germination the following season. Glysophate has no soil activity[4]. As such, application of glyphosate should be done to targeted *T. capensis* after senescence of other indigenous species (during the Western Cape dry season) to minimise effects (Hazelton *et al*. 2014). Adding a surfactant or emulsifier is recommended as *T. capensis* have a thick waxy coating on the leaf. Commercial herbicides containing Triclopyr includes Confront 360 and Garlon 3A. The abovementioned herbicides are available in separate formulas for application either on aquatic or terrestrial sites. Improper use of the terrestrial formulations in an aquatic habitat may harm fish and macro invertebrates and therefore label instructions may not be exceeded due to negative impacts on surrounding flora and fauna. The chosen herbicide must be registered for use in aquatic environments, as an unregistered product may have detrimental impacts to the aquatic environment. No application of herbicide may occur during amphibian or avifaunal breeding season, or when eggs and tadpoles are present. During the application process, herbicide may only be mixed in the contractor laydown area and spray drift and herbicide run-off must be kept to a minimum. No application of herbicides is allowed within any waterlogged zones or directly into the water. Additionally, herbicide application should take place within the context of LandCare recommendations and other best management practices as stipulated by the municipality and/or regulating authority. The most effective for the treatment of *T. capensis*: *Foliar Treatment (see Appendix C for description of mechanisms used to control AIPs and weed species):* Spray should be applied to wet the leaves and, when present, the flower plumes of the target plants. Excessive application, such that the chemicals are dripping off the plants, should be avoided due to injuries to desirable other indigenous plants. This application can be undertaken in areas where *T. capensis* is dense, with limited other species (NRCS, 2013). Foliar spray can be applied to regrowth that is up to the height of 1 m. Herbicide must be applied using knapsacks with solid cone nozzle and must be mixed with a suitable dye to prevent over- or under spraying of treated areas.

[4] A weed report from the book weed control in natural areas I the western united states.

Control of *Cyperus papyrus* within the dams and channels.	 *Cyperus papyrus* is an AIP which is comonly utilised as a nursery ornamental plant, however, it does escape into open waterbodies. Like *Typha capensis, C. papyrus* has rhizomes that form mats of floating vegetation within waterbodies as a result of rhizomes and the floating stems of other aquatic plants become intertwined. These mats can become extensive, outcompeting other indigenous species and reducing light penetration and oxygenation of water. Mechanical removal In order to prevent further *C. papyrus* spread the use of physical, biological, and chemical controls are necessary. Manually cutting and raking of the cut materials is considered the best method of dealing with *C. papyrus*, and this can either be done with sickles or specialized and powered mechanical cutters (as discussed for *T. capensis* above). Once cut the material must be removed through hand raking (preferrably) and removed from the dam. Control of rhizomes and sediment Please refer to mitigation measures stipulated for *Typha capensis.* Biological Control Research on control methods of *C. papyrus* (https://www.cabi.org/isc/datasheet/17503#tohabitat) indicates that biological control can be achieved by the production of toxin from a novel fungal isolate. The novel isolate, *Dactylaria higginsii (Pseudopyricularia higginsii),* can be grown, and the toxins recovered.The fungus can be used to directly and specifically deliver its phytotoxin composition to *C. papyrus*. This is delivered to the plant by applying an effective amount of the biologically-active fungus directly to the plant. The fungus produces sufficient quantities of a phytotoxin compound to inhibit the growth, or actually induce mortality of *C. papyrus*. The growth of the fungus can also mechanically disrupt nutrient transport in the vascular system of the plant. This material has been developed as a bioherbicide for the control of weedy sedges like *Cyperus rotundus* (Kadir and Charudattan, 2000) but there seems to be no confirmed evidence of its effectiveness on *C. papyrus* nor on the long term effects to other plant species in the environment. Herbicide use As with *T. capensis* both, Glyphosate and Triclopyr can be used to control *C. papyrus* effectively when used properly. Application includes foliar treatment as well as cut stem treatment (refer to Appendix C) where plants are cut to at least waist height and one drop of herbicide is applied to the stems with a squirt bottle or syringe. It is again important to note that improper use of herbicides in an aquatic habitat may harm fish and macro invertebrates and therefore label instructions may not be exceeded due to negative impacts on surrounding flora and fauna.
Control of water lilies and other floating material within the dams	 *Nymphoides spp.* and *Nymphaea spp.* are indigenous to South Africa (with exception of *Nymphaea Mexicana* which is considered an alien species originating from Mexico) and are often found in freshwater ponds and dams. If left unmanaged they can form large, dense spreading colonies to a depth of 3 m and large leaves dominate the water surface, restricting light penetration and impacting other attached, floating-leaved[5] species and can cause silting up of dams. Mechanical removal only (no other removal techniques are recommended) If the lilies are still small and the roots are not too tangled it is possible to rack the lilies by hand, pulling them towards the shoreline and then easily removing them by hand. In instances where more established larger individuals have taken hold, they will not be as easy to remove and may need to be pulled with some force to remove. The following method statement is applicable: ➢ For lilies within 1 m of the shoreline, a rack or personnel wading in the water can access the lily pads and pull them towards the shoreline. It is important that the lilies be removed with their roots. ➢ For deeper individuals, a small boat or barge (shoal-draft flat-bottomed boat) can be made use of, and personnel can pull the lily out by grabbing hold of the leave and pulling it free from the substrate. It is important that the lilies be removed with their roots. ➢ Any other floating mats of plant material, especially where sub-surface plant material has come loose and floated to the surface should be manually removed with a rake (or from a small boat in deeper

[5] *Attached floating-leaved is a category used for plants that are rooted in the substrate with mature leaves floating on the surface of the water.*

	water) and not left on the dam surface as this material can rot causing undesirable odours to arise and cause eutrophication of the da water which could impact aquatic species. ➢ All removed plant material must be removed from the water and disposed of at a suitable composting site. ➢ Not all water lilies should be removed as these plants provide both aesthetic value to the dams as well as habitat for various aquatic species (aquatic avifauna and amphibians) and thus indigenous species should be maintained in smaller clusters in shallower water (near the edges of the dams). Any AIP species (*Nymphaea Mexicana* – Yellow water Lily) should be removed.
Removal of excess sediment within the dams	➢ Areas which have been cleared of vegetation, including stockpile areas, must remain as small as possible, in order to reduce the risk of proliferation of alien vegetation, and in order to retain a level of protection to the dams during the rehabilitation works. ➢ Sediment can be removed from within the dams, specifically within the first 2 m from the edge of the dam to assist in removal of AIP and encroacher species rhizomes and also to maintain storage capacity. This removal can be done manually or with the use of a small digger. ➢ Any removal of sediment close to artificial channel outlets should have sediment traps installed to prevent loosened sediments from washing into downgradient channels which could cause blockages. ➢ All silt removed from the dams must be disposed of at a suitably licenced waste facility and may not be left stockpiled on site. Should the proponent wish to utilise the silt elsewhere on site, the relevant environmental consultant must be contacted, and a plan of action put in place prior to spoiling of material. ➢ On completion of works, all embankments disturbed by the silt removal must be ripped and loosened. It is recommended that indigenous freshwater plant species be reinstated to prevent proliferation of alien and invasive species or encroacher species that have already been removed. ➢ Alien species proliferation will need to be monitored and removed from the dam and surroundings (in line with the sections above). It is recommended that all alien vegetation be removed by hand and the use of chemicals is limited to when absolutely necessary, in order to prevent die back of remaining indigenous vegetation and prevent contamination of surface water.
Removal of excess sediment within the artificial channels	Sedimentation within the artificial channels can result in blockages, reducing flow to downstream areas. Furthermore, sediment build up can result in the proliferation of unwanted vegetation (such as *Typha capensis* that has been known to prefer sediment laden areas). As such, removal of sediment and unwanted vegetation is imperative for the long term maintenance and functioning of the system as a whole. The following should be implemented when working within the channels: ➢ Sediment traps should be installed downstream of the proposed area where sediment is to be removed (preferably prior to vegetation clearing activities to trap any cut material from establishing downstream). Geotextile wrapped hay bales or geotextile mesh with cobbles are considered suitable (Figure 3 below).  **Figure 3: Sediment traps to be used during vegetation clearing or sediment removal.** ➢ All sediment areas should be cleared by hand given the narrow area associated with the artificial channels. Sediment can be loaded into buckets or wheelbarrows and removed. The use of machinery will compromise the embankments of the channels which will in urn lead to further erosion and sediment build-up. ➢ Sediment removal should be done systematically with the removal of vegetation, in line with the above mentioned methodologies. ➢ All removed sediment must be disposed of at a suitably licenced waste facility and may not be left stockpiled on site. Should the proponent wish to utilise the silt elsewhere on site, the relevant

	environmental consultant must be contacted, and a plan of action put in place prior to spoiling of material.
Revegetation	All areas where extensive removal of the above mentioned vegetation has been undertaken should be reinstated with indigenous vegetation to prevent proliferation of removed species. Inclusion of indigenous plants adapted to life in saturated soils must be selected for the edges of the dams and the artificial channels. Vegetation species selected for the rehabilitation must be hardy and should be able to withstand: ➢ Extended periods of drought as dam levels may fluctuate and artificial channels may be dry during the summer months; ➢ Elevated nutrients due to the surrounding golf course and potential run-off there from; ➢ Periodic inundation (it is assumed that inundation may occur during the rainy season, during storm events as well as within the dams); ➢ Plants must be readily available; and ➢ Plants must establish rapidly to prevent proliferation of alien and invasive species. Refer to the MMP compiled by GNEC (2022) for the recommended indigenous vegetation species to be established in the various wetness zones of the dams and channels. Furthermore, alien and invasive vegetation proliferation must be monitored and pulled by hand. Use of chemicals should be avoided.

3. MONITORING REQUIREMENTS

On completion of vegetation and sediment removal activities, monitoring is considered imperative to ensure the long-term success of the works. It must be noted that it is considered likely that vegetation will need to be annually cut/managed as water quality within the dams plays a large role in the proliferation of floating vegetation species (specifically if water has high nutrient loads). It is important that monitoring be carried out to determine the efficiency of the rehabilitation works, and to determine the costs and the allocation of time and manpower to repeat exercises. The following table presents the principles that should be followed as part of the monitoring of vegetation.

Table 2: Applicable monitoring activities

AIM:	Implementing maintenance activities and monitoring the re-emergence of alien and encroacher species.	**MOTIVATION**	There will always be some measure of regeneration of the cleared AIPs and encroacher species after the initial clearing work has been done. Proper follow-up work is thus essential and should be conducted regularly. If follow-up clearing is not done, the progress made in the initial clearing exercise will be lost within a few years as the vegetation become re-established. Additionally, to assess the impact of the clearing activities, follow-ups and rehabilitation efforts, monitoring must be undertaken.
MAINTENANCE & MITIGATION MEASURES			
1	Before embarking on a monitoring programme, ensure that the following is determined: ➢ Who will do the monitoring; ➢ How often it will be undertaken; ➢ What variables will be monitored (percentage cover, the height of seedlings etc.); ➢ What methods will be used (visual, photographic or more scientific methods); ➢ How the data will be stored (spreadsheets, maps, photographs or a combination these); and ➢ How the data will be utilised (when will the data be interrogated, i.e. planning the follow-up work).		
2	Monitoring of each of the management areas (identified during the initial clearing) should include the following: ➢ Name or number of the management area; ➢ GPS location of the management area; ➢ Date of assessment; ➢ Description of the issues associated with each management area, e.g. additional vegetation clearing required and/or sediment loads require additional removal; and ➢ Priority of the maintenance tasks.		

3	After the implementation of initial control methods, the identified alien/invasive communities should be assessed in monthly intervals for a period of three months after the initial treatment to control any species that may resprout. Thereafter an annual assessment of the alien vegetation stands should take place after the spring flush of each year but prior to seed formation. The annual assessment should include: ➢ Determination of the extent of each alien or invasive vegetation community that has re-established/re-coppiced. ➢ Determination of dominance by biomass and recruitment within each alien or encroacher vegetation community. To identify any dominant species that may become a threat to the natural vegetation.
4	Preventing new AIPs from establishing is more cost-effective than implementing continual clearing programs and therefore un-invaded areas or areas that have been cleared must be protected from invasion through the establishment of additional indigenous vegetation.
5	Maintenance schedule to be strictly followed: ➢ Monitoring and maintenance of emerging vegetation and the re-emergence of seedlings to take place biannually. Remove by hand-pulling. ➢ The build-up of sediment and debris within the artificial channels is to be inspected, and maintained as needed, on a bi-annual basis.
6	Photographs of the site should be taken to assist the process of monitoring the impact of the clearing programme.

This MMP for the Pearl Valley dams and artificial channels promotes the recovery of indigenous flora and ecological integrity of the dams within the Pearl Valley Golf Estate. The success of the removal of the vegetation species as discussed herein from the dams and artificial channels is dependent on the proponent to ensure all the measures proposed in this report will be carried out. This report should be read in conjunction with the MMP compiled by GNEC (2022).

It is the opinion of the consultant that should the activities as presented in this MMP be executed in a cogent and well-managed fashion the water quality and aquatic fauna that utilise the dams will not be negatively impacted.

Kind Regards,

Kim Marais
Pr. Sci. Nat

Peer reviewed by Christel du Preez (Pr. Sci. Nat)

Appendix A: Maps associated with the study area

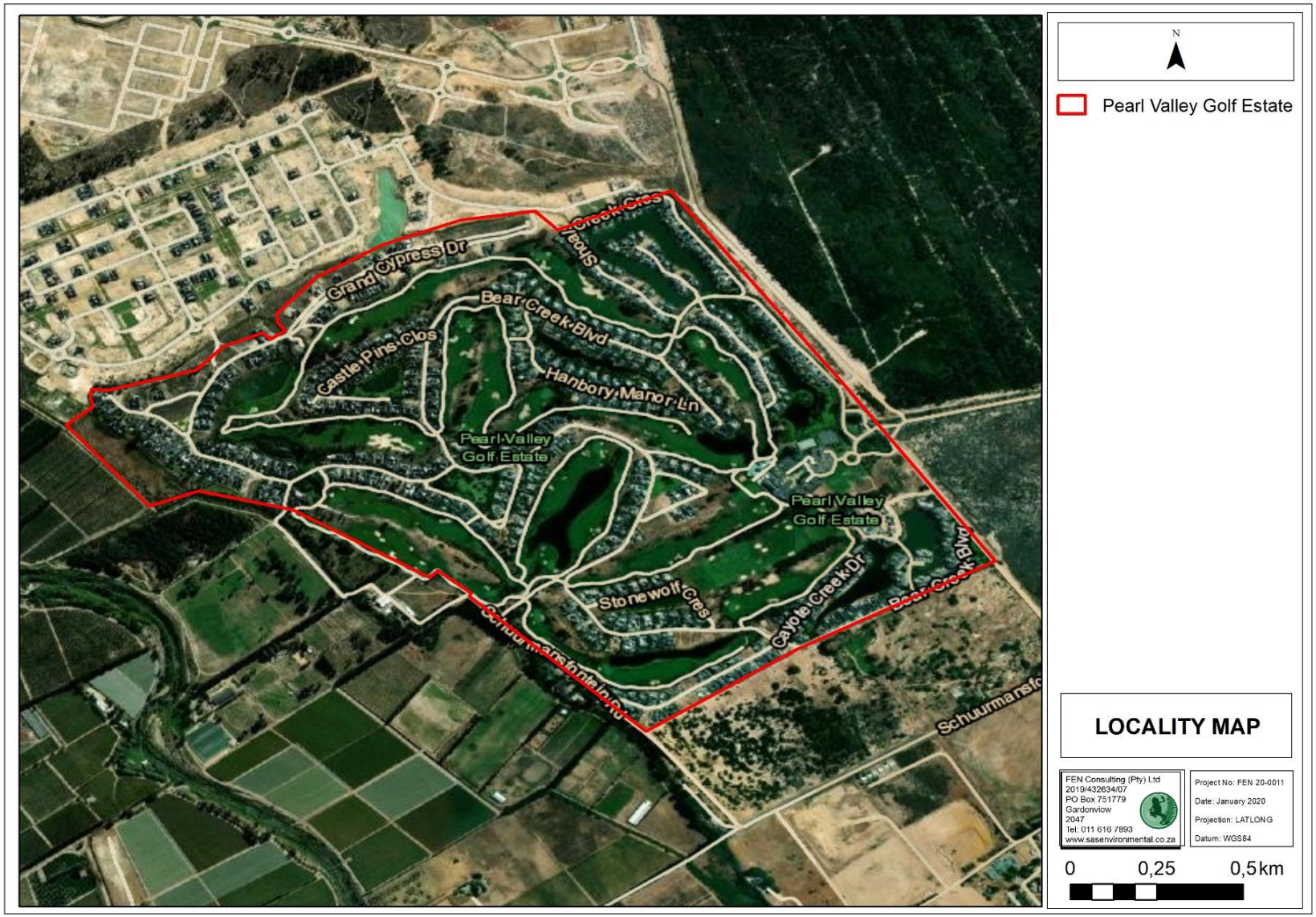


Figure 1: Location of the study area in relation to the surroundings

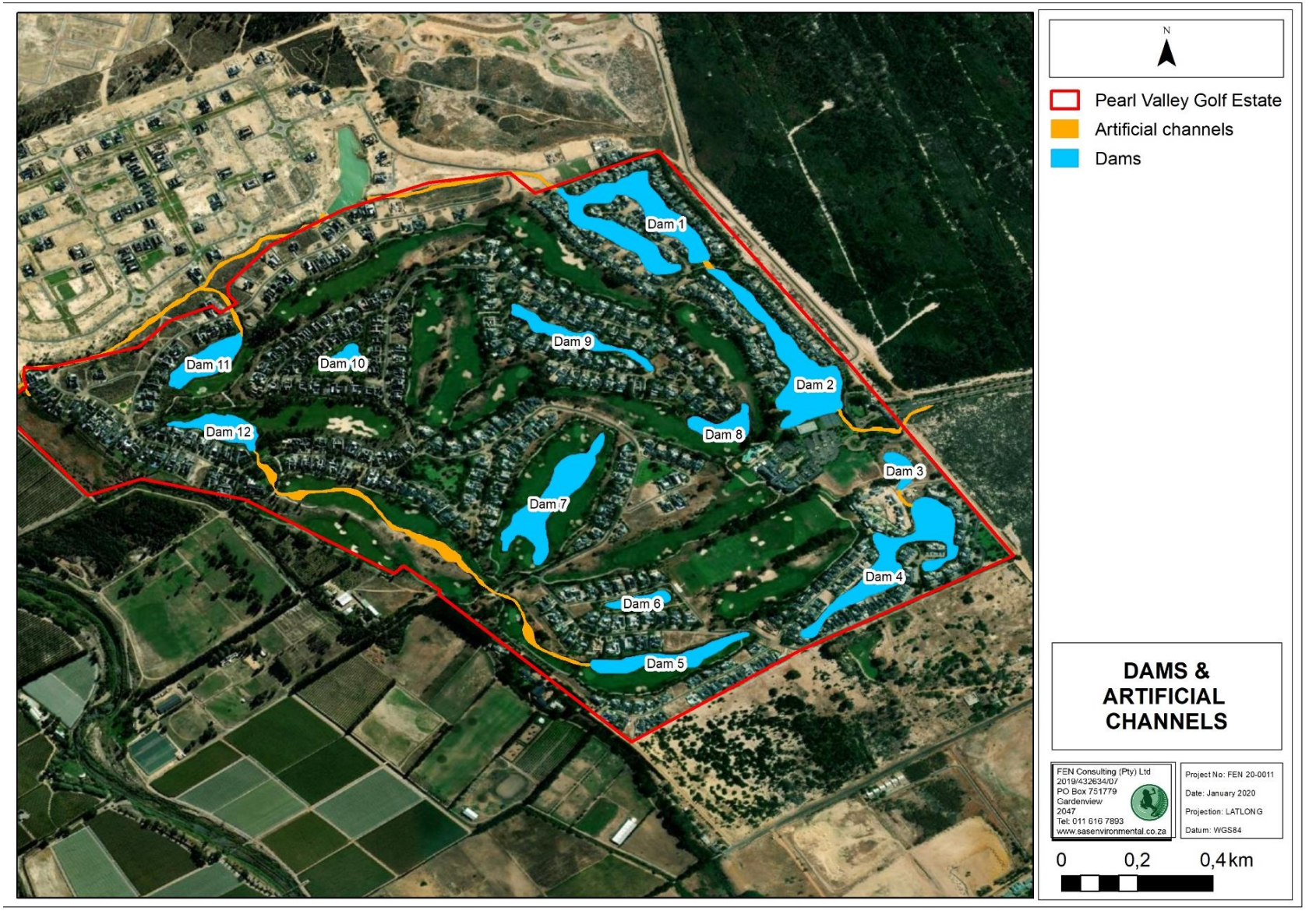
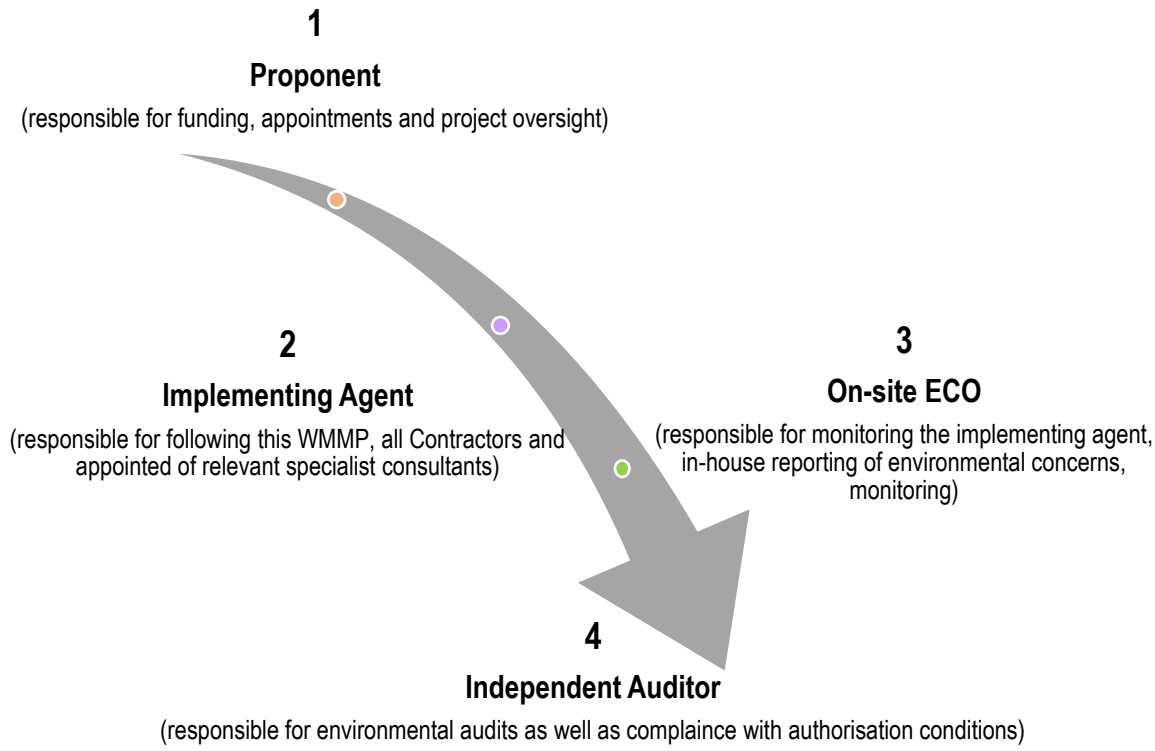


Figure 2: Location of dams and artificial channels within eh Pearl Valley Golf Estate

Appendix B: Roles and Responsibilities

The success of the maintenance and management efforts is highly dependent upon cogent conceptual planning undertaken throughout the life of the development. A list of the roles and responsibilities (if and where applicable) of the individuals involved in the implementation of this MMP is provided in the table below.

Table B1: Summary of various parties involved with the implementation of this WMMP.



Party	Responsibility
Proponent	• The Proponent must ensure sufficient funding for the implementation and long-term maintenance of the mandated rehabilitation requirements as stipulated in this report; • The Proponent will be responsible for the appointment of an Environmental Control Officer (ECO) to monitor and audit the rehabilitation requirements, the Implementing Agent, as well as an independent auditor; • The Proponent will be responsible for ensuring the Implementing Agent receives a copy of this document and understand its contents; and • The proponent must give the authority to the on-site ECO to stop works on site should he/she feel that there is a serious threat to or impact on the surrounding environment.
Implementing Agent	• An overarching Contractor should be appointed as the Implementing Agent, to manage all sub-contractors and appoint specialists, as required; • The Implementing Agent must ensure that all sub-contractor/s take full responsibility for each of his/her employees and any penalties imposed; • The Implementing Agent must immediately inform the Proponent and on-site ECO if any changes to the project are envisaged and if any aspects of this implementation plan or the RoD cannot be complied with; • It is the responsibility of the Implementing Agent to ensure that the measures stipulated within this WMMP are adhered to; and • Should the Implementing Agent require clarity on any aspect of this WMMP, the Implementing Agent must contact the on-site ECO for advice or alternatively, a suitably qualified specialist.

	Training of Rehabilitation Workers The Implementing Agency is to facilitate an initial environmental induction to all sub-contractors and associated workers in environmental awareness, including minimisation of disturbance to areas of increased ecological sensitivity, as well as fauna and flora with a no poaching policy, management of waste and prevention of water pollution. Furthermore, the Implementing Agent is to ensure that all operational workers have received basic training on fire management and prevention measures and be aware of any emergency protocols required. **Contractor Performance** The Implementing Agency must ensure that the relevant sub-contractors adhere to the conditions of this Implementation Plan. Should the Contractor require clarity on any aspect of this WMMP, the Contractor must contact the Implementing Agency directly, who, if needed can consult with the specialists involved in the WMMP. Should the on-site ECO feel that the conditions of the WMMP is not being met by the Contractor(s), the on-site ECO has been given the authority by the Proponent to stop works if in his/her opinion there is/may be a serious threat to or impact on the surrounding environment and instruct the contractor(s) on suitable rectification and remediation actions that must be implemented immediately.
On-site Environmental Control Officer (ECO)	The on-site ECO is the person responsible for the day-to-day monitoring of the Implementing Agent's activities. The on-site ECO should ideally be appointed before the start of construction works so as to record baseline conditions and will be responsible for ensuring that all rehabilitation activities are implemented. The on-site ECO is mandated to do the following: • Ensure that all Implementing Agent's employees are fully aware of their environmental responsibilities and the sensitivities of the site. This should take the form of an initial environmental awareness-training program in which requirements of this document will be explained; • Monitor site activities on a regular basis to ensure that there is minimal unintended environmental impact to the surrounding areas as well as the areas to be rehabilitated; • Monitor the site activities and rehabilitation actions in line with this WMMP as well as any relevant licences/Records of Decision (RoD); • The on-site ECO should have all relevant contact details for the team responsible for implementation of this plan and any rapid response units, as needed should additional clarity be required; • Ensure that a 'hotline' exists for reporting incidents, specifically unplanned/uncontrolled fires breaking out and resolving any problems rapidly; • Compile a monthly status report, indicating any non-compliances as well as progress made on the implementation of this WMMP; and • Monitor all proposed dam activities and ensure efficient remediation/mitigation measures are implemented, as deemed necessary. A monthly monitoring report must be compiled.
Independent Auditor	The independent auditor must be suitably qualified with relevant experience to undertake external audits of the findings of the on-site ECO, in line with the conditions stipulated within the Environmental Authorisation (EA) and relevant Water Use Authorisation (WUA). The independent auditor will: • Conduct all audits in line with the relevant authorisation requirements and a review of management and rehabilitation measures; • Undertake a site visit to discuss the findings with the on-site ECO and ensure that the rehabilitation activities are complaint; and • Compile a relevant audit and monitoring report which is to be submitted to the relevant provincial authorities.

Appendix C: Mechanisms for AIP and encroacher species removal

The following definitions and methods are applicable to the control of aquatic species within the identified dams/channels. When herbicides/chemicals are used as part of the control measures, it must be applied by a suitably qualified person or organisation.

Table C1: Manual and mechanized methods of clearing of aquatic species.

Risk to Ecosystem	Infestation density & plant size targeted	Required tools	Photograph reference
HAND-PULLING Saplings and seedlings must be pulled out by hand. All root material should be removed to avoid re-sprouting of the plant.			
Safe to use in the dams as no chemicals are used. Hand pulling does create soil disturbance, but if the area is sparsely invaded such disturbances are unlikely to be ecologically damaging.	• Low or sparse infestation. • Aimed at seedlings and saplings or loosely rooted aquatic species: Plants that are small enough to be pulled out with roots intact.	• No special tools required. • Waders recommended to avoid getting wet.	
SLASHING			
Low No contamination of water as usually manual tool.	• Low or sparse infestation. • The seed stalks, leaves of *Typha capensis* can be slashed below the waterline.	• Slashed with a cane knife, mattock, bill hook or slasher.	
BRUSH CUTTING			
Possible pollution caused by bar oil.	• Dense stands can be cleared. • Popular for controlling low-growing thickets of AIPs.	• Heavy duty motorised brush-cutters that are usually powered by a small two-stroke engine.	
CHAINSAW			
Possible pollution caused by bar oil.	• Dense stands can be cleared. • For felling large trees and can be used to cut logs and branches into shorter lengths.	• A chainsaw	

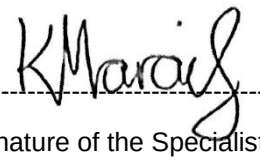
Table C2: Manual and mechanized methods for the application of herbicide

Picture reference	Method	Type of Weed	Equipment Required	Notes
	Foliar Spray	Herbs, Bulbs, Woody weeds	Knapsack Vehicle mounted tank Herbicide mix	Ensure herbicide is being applied at the right concentration and rate to cover the foliage of the pest plant with fine droplets and avoid run-off. A flat-fan nozzle and low pump pressure will assist in reducing spray drift.
	Cut stem	Woody species, hollow reeds	Brush cutter, chainsaw, loppers Herbicide mix Bush / sponge for herbicide application	Ensure herbicide is applied quickly to cut stem (usually within 30 seconds). Apply during active growing period of plant for best results Do not apply herbicide to the point of run-off.

Appendix D: Declaration of independence and CVs of the specialists that compiled this MMP

I, Kim Marais, declare that -

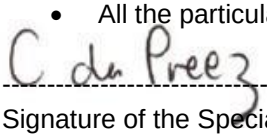
- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct



Signature of the Specialist

I, Christel du Preez, declare that -

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the relevant legislation and any guidelines that have relevance to the proposed activity;
- I will comply with the applicable legislation;
- I have not, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing - any decision to be taken with respect to the application by the competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct



Signature of the Specialist

SAS ENVIRONMENTAL GROUP OF COMPANIES –

SPECIALIST CONSULTANT INFORMATION

FRESHWATER ECOLOGIST NETWORK CONSULTING – SPECIALIST CONSULTANT INFORMATION
CURRICULUM VITAE OF CHRISTEL DU PREEZ

PERSONAL DETAILS

Position in Company	Freshwater Ecologist
Date of Birth	22 March 1990
Nationality	South African
Languages	English, Afrikaans
Joined SAS	January 2016

EDUCATION

Qualifications

- MSc Environmental Sciences (North West University) 2017
- BSc Hons Environmental Sciences (North West University) 2012
- BSc Environmental and Biological Sciences (North West University) 2011

Additional training and courses

- Wetland and Aquatic plant Identification presented by Carin van Ginkel February 2019
- Wetland Management: Introduction and Delineation presented by the Centre of Environmental Management University of the Free State November 2018
- Tools for Wetland Assessment presented by Prof. F. Ellery and Rhodes University February 2018
- Basic Principles of ecological rehabilitation and mine closure presented by the Centre for Environmental Management North West University October 2015

COUNTRIES OF WORK EXPERIENCE

South Africa – Western Cape, Eastern Cape, Northern Cape, Gauteng and Mpumalanga

SELECTED PROJECT EXAMPLES

Watercourse Ecological Assessments

- Freshwater resource and aquatic ecological assessment for the proposed West Wits Mining project, in Soweto, Gauteng Province
- Freshwater resource assessment and hydropedological assessment as part of the Water Use License process for the proposed Vlaklaagte 2 Seam, Block 6 coal mining operation, near Kriel, Mpumalanga Province
- Freshwater resource assessment as part of the Water Use License application process for the proposed Middelvlei Mine Project, situated on the remaining extent of portion 2 and 3 of the farm Middelvlei 255-Iq, Randfontein, Gauteng Province
- Freshwater resource assessment as part of the Environmental Assessment and Water Use Authorisation process for the proposed Cygnus Mining Project, Limpopo Province
- Watercourse impact assessment as part of the Environmental Impact Assessment (EIA) for the proposed Hyperion Solar Development 1 - 4, near Kathu, Northern Cape Province

- Freshwater resource ecological assessment as part of the Environmental Assessment and Water Use Authorisation process for the proposed industrial development on farm Cumberland No. 915, Simondium, near Paarl, Western Cape Province
- Watercourse ecological assessment as part of the Environmental Assessment and authorisation process for the proposed periodic maintenance of the MR201 Road (Bain's Kloof Pass), between Wellington and Breederivier, Western Cape Province
- Freshwater resource ecological assessment as part of the Environmental Assessment and Authorisation Processes for the proposed development on portion 12 of the Vergenoegd Farm, Western Cape Province

Watercourse Rehabilitation, Implementation and Management Plans

- Residual wetland impact compensation plan for the proposed extension of Erica Drive from Belhar to Oakdene over the R300 and dualling of Erica Drive / Belhar Main Road, east of Reuter Street, over the Kuils River, Western Cape Province
- Surface water Rehabilitation and Management Plan for the proposed development of portion 204 of the farm Alewynspoort145, Near Alberton Gauteng Province
- Surface water Rehabilitation and Management Plan as part of the Water Use Authorisation requirements for the Twickenham Platinum Mine, Limpopo Province
- Surface water Rehabilitation and Management Plan as part of the Water Use License Application process for the United Manganese of Kalahari (UMK) Mine, near Hotazel, Northern Cape Province

Landscape Plans

- Landscape Plan as part of the WUL application and Environmental authorisation for the proposed extension of the Twickenham Mine, Limpopo Province
- Landscape and Plant Species Plan as part of the proposed Avianto Function development, Gauteng Province
- Landscape and Plant Species Plan for the Mokala Mine, near Black Rock, Northern Cape Province
- Landscape Plan as part of the Rehabilitation and Management Plan for the proposed road upgrade near Vlakfontein, Gauteng Province

SAS ENVIRONMENTAL GROUP OF COMPANIES –

SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF KIM MARAIS

PERSONAL DETAILS

Position in Company	Senior Scientist Water Resource Manager
Joined SAS Environmental Group of Companies	2015

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Professional member of the South African Council for Natural Scientific Professions (SACNASP – Reg No. 117137/17)
Member of the Western Cape Wetland Forum (WCWF)

EDUCATION

Qualifications

BSc (Hons) Zoology (University of the Witwatersrand)	2012
BSc (Zoology and Conservation) (University of the Witwatersrand)	2011

Short Courses

Aquatic and Wetland Plant Identification (Cripsis Environment)	2019
Tools for Wetland Assessment (Rhodes University)	2018
Certificate in Environmental Law for Environmental Managers (CEM)	2014
Certificate for Introduction to Environmental Management (CEM)	2013

AREAS OF WORK EXPERIENCE

South Africa – Gauteng, Mpumalanga, KwaZulu-Natal, Northern Cape, Eastern Cape,
Africa - Uganda

KEY SPECIALIST DISCIPLINES

Biodiversity Assessments

- Biodiversity Action Plans (BAP)
- Alien and Invasive Control Plans (AICP)
- Faunal Eco Scans
- Faunal Impact Assessments

Freshwater Assessments

- Desktop Freshwater Delineation
- Freshwater Verification Assessment
- Freshwater (wetland / riparian) Delineation and Assessment
- Freshwater Eco Service and Status Determination
- Rehabilitation Assessment / Planning
- Watercourse Maintenance and Management Plans
- Freshwater Offset Plans

Aquatic Ecological Assessment and Water Quality Studies

- Riparian Vegetation Integrity (VEGRAI)
- Water quality Monitoring
- Riverine Rehabilitation Plans

Legislative Requirements, Processes and Assessments

- Water Use Applications (Water Use Licence Applications / General Authorisations)
- Water Use Audits
- Freshwater Resource Management and Monitoring as part of EMPR and WUL conditions
- Public Participation processes