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AQUATIC BIODIVERSITY ASSESSMENT

FOR

MINING PROPOSED ON PORTION 12 OF JAN HARMENS GAT FARM 179, BONNIEVALE

PREPARED FOR: TVM Construction
PO Box 266
Stasiestraat
SWELLENDAM, 6740

PREPARED BY: Sharples Environmental Services cc
Contact Person: Debbie Fordham
Email: debbie@sescc.net

DATE: 16 November 2021

DECLARATION OF INDEPENDENCE

I, Debbie Fordham, declare that I:

- Act as an independent specialist consultant, in this application, in the field of wetland ecology;
- Do not have and will not have any financial interest in the undertaking of the activity, other than remuneration for work performed in terms of the amended EIA Regulations, 2014 (amended);
- Have, and will have, no vested interest in the proposed activity proceeding;
- Have no, and will not engage in, conflicting interests in the undertaking of the activity;
- Undertake to disclose, to the competent authority, any material information that have or may have the potential to influence the decision of the competent authority or the objectivity of any report, plan or document required in terms of the amended EIA Regulations, 2014; and
- Will provide the competent authority with access to all the information at my disposal regarding the application, whether such information is favourable to the applicant or not.

The following report has been prepared:

- As per the requirements of Section 32 (3) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) Environmental Impact Assessment Regulations 2017 as per Government Notice No. 326 Government Gazette, 7 April 2017.
- In accordance with Section 13: General Requirements for Environmental Assessment Practitioners (EAPs) and Specialists as well as per Appendix 6 of GNR 982 - Environmental Impact Assessment 2014 Regulations and the National Environmental Management Act, 1998.
- With consideration to Cape Nature's standard requirements for biodiversity assessments.
- In accordance with DEA&DP's Guideline on Involving biodiversity specialists in the EIA process.
- Independently of influence or prejudice by any parties.

AQUATIC SPECIALIST

The Debbie Fordham, the author of this report, is in agreeance with the 'Declaration of Independence'.

SPECIALIST	QUALIFICATIONS	DETAILS
DEBBIE FORDHAM M.Sc	M.Sc - Environmental Science BA (Hons) - Environmental Science BA - Environmental Science and Geography	Debbie is a qualified aquatic ecologist. She holds a BA (Environmental Science and Geography), BA (Hons) and M.Sc in Environmental Science from Rhodes University. She was awarded her Master of Science degree, by thesis, in Wetland Science, entitled: The origin and evolution of the Tierkloof Wetland, a peatland dominated by *Prionium serratum* in the Western Cape. She has specialised in aquatic habitat assessment and has produced numerous aquatic habitat impact assessment reports. She is well established in her specialist field and has worked in various provinces within South Africa.

SUMMARY

The study area is situated approximately midway between the towns of Swellendam and Ashton on the eastern side of the R60 Road. The site is located on untransformed farmland; however, a significant portion of the proposed site is already disturbed. The study area is located within the H50B quaternary catchment of the Breede Water Management Area. The drainage basin in which the site is located drains towards the Nooitgedag River which is a tributary of the Breede River. According to the desktop data there is no aquatic habitat within the proposed mining site, however, a seep wetland is shown to be situated south and downslope of the proposed site boundary. Following desktop investigations, the infield site assessment (conducted on the 24th of August 2020) confirmed the location and extent of these systems. It was determined that the wetland, located approximately 70 m downslope, as well as the alluvial fan to the north of the site, are fluvial features that may be impacted upon by mining.

Three alternative proposals were assessed for their impact upon aquatic biodiversity, namely:

- *Alternative 1: the original site location,*
- *Alternative 2: the preferred site*
- *No-Go Alternative: the status quo remains*

Both mining Alternatives scored a Low impact rating, and either is acceptable, after the adoption of mitigation measures. Alternative 2 has a slightly larger footprint and is in closer proximity to the wetland.

It is recommended that a 32 m aquatic buffer zone be adopted between the mining area and the watercourse to the south east of the site. The furthest distance between activities and the watercourse must be maintained. Monitoring implementation and management of the final buffer areas should be undertaken throughout the duration of mining activities to ensure that the effectiveness of the buffer zone areas is maintained, and that management measures are appropriately implemented.

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1 INTRODUCTION

Sharples Environmental Services cc (SES) has been appointed by *TVM Construction,* to undertake the Aquatic Biodiversity Impact Assessment for the proposed sand mining on Portion 12 of Jan Harmens Gat Farm 179, near Bonnievale. The study is part of a mining permit application in order to fulfil the requirements of the Department of Mineral Resources.

In 2020, SES produced an Aquatic Biodiversity Screening Assessment report to identify and delineate aquatic features relative to the proposed site. The aquatic screening report assessed the status quo of aquatic biodiversity and ecological processes, identified constraints, and provided maps of the sensitive areas. Following these findings, and those of other specialists, an alternative mining footprint has since been identified for inclusion in the environmental authorisation application. The refined site location is now proposed as a Preferred Alternative layout. Therefore, further aquatic specialist input is required to assess the new information and respond to relevant comments generated during the Draft BAR public participation process.

1.1 Location

The study area is situated approximately midway between the towns of Swellendam and Ashton on the eastern side of the R60 Road. The site lies at the foot of the Langeberg Mountain range, in an agricultural area, with the protected area named Marloth Nature Reserve upslope. Figure 1 shows the location of the study area in relation to the R60 Road and mountain foothills.

The site is located on untransformed farmland, however, a significant portion of the proposed site is already disturbed. There is bare ground exposed with sparse vegetation in this section (Figure 2). It is potentially as a result of sand removal by the farmer or agricultural activities. There is evidence of relatively recent earthworks. The remainder of the site is in natural or near natural condition. Google satellite imagery indicates that a wildfire occurred in 2013 (this is part of the natural fire regime of the ecosystem). There are areas which show the impacts of past grazing practices, as well as areas where Hakea plants have invaded, but the general ecological condition remains exceptionally good.

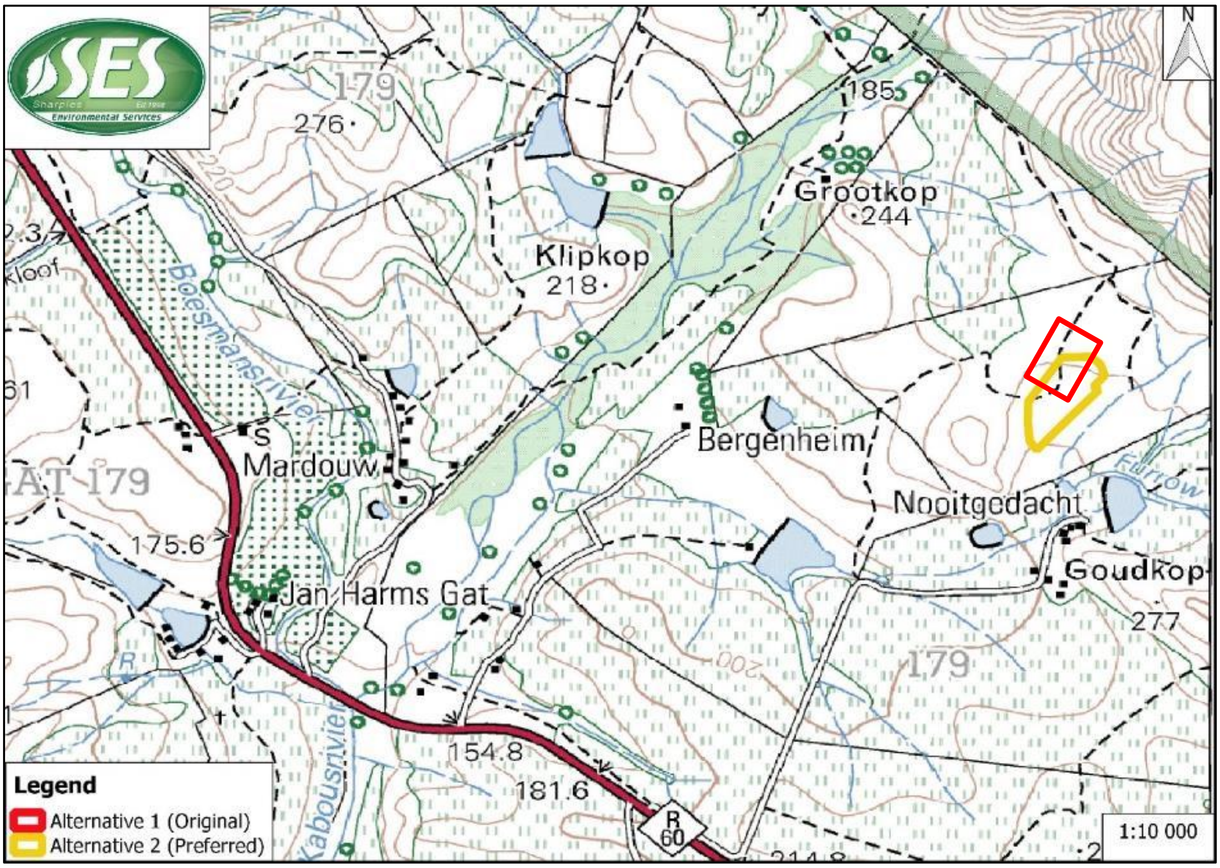

Figure 1: Cadastral map of the potential sites on Jan Harmens Gat Farm 179

Figure 2: Photograph showing the disturbed portion of the proposed site

1.2 Alternatives for assessment

Three alternative proposals were assessed for their impact upon aquatic biodiversity (Figure 3), namely:

- Alternative 1: the original rectangular site location,
- Alternative 2 (the preferred site): similarly shaped but shifted slightly towards the south,
- The No-Go Alternative: the status quo remains and there is no disturbance to the site from mining (it also assumes that alien vegetation will be managed).

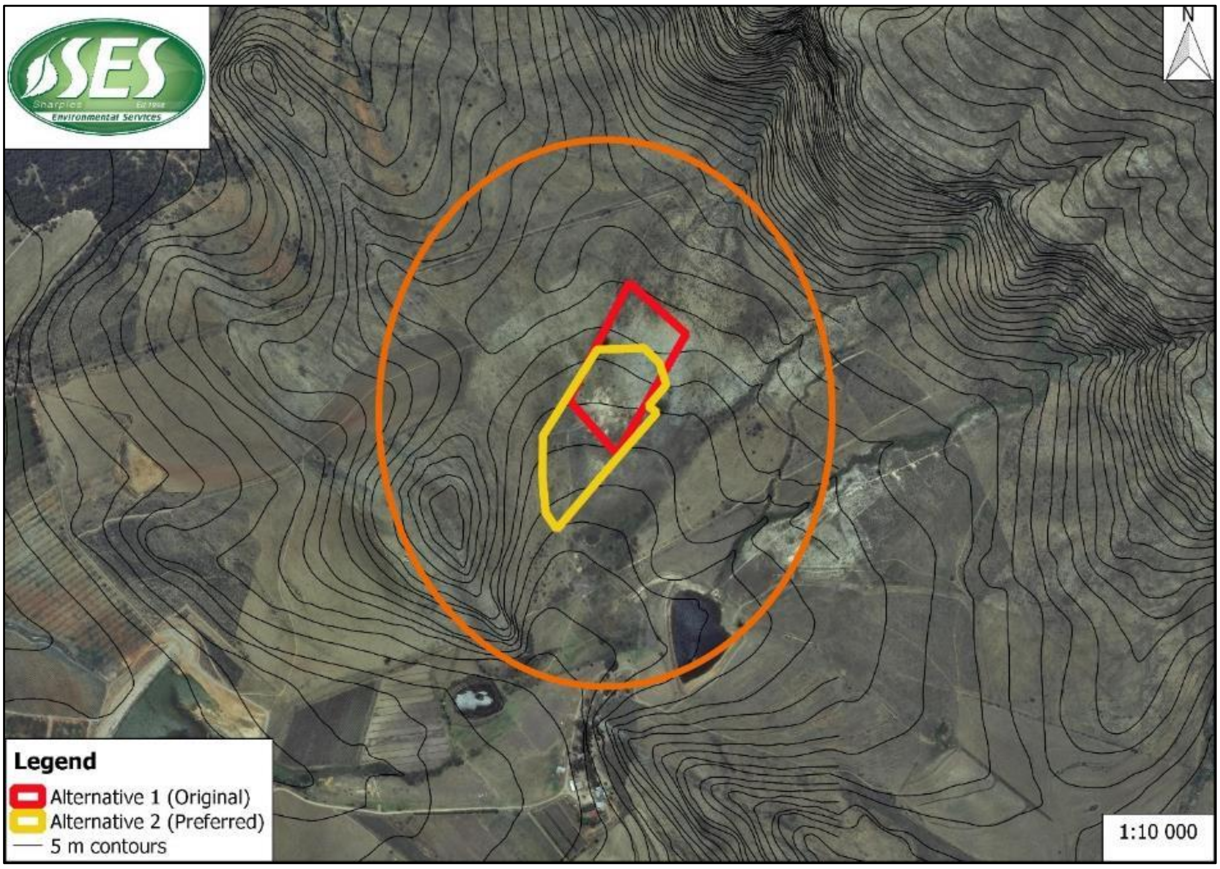

Figure 3: Map showing the two mining site alternatives and the 500m radius Regulated Area (in terms of the NWA, Act 36 of 1998)

1.3 CapeNature comment on the Draft BAR (2021)

Below are comments of CapeNature, relative to aquatic habitat, which are addressed in the report:

- *The aquatic biodiversity screening assessment delineated the freshwater features occurring on the property. It should be noted that the aquatic assessment is dated August 2020 and therefore the original proposed mining footprint was assessed.*
- *The delineation of the freshwater features differs from the desktop mapping (NGI and NFEPA/NBA). Two alluvial fans were identified at the base of the slopes where the watercourses exit the mountains and result in the dissipation of the watercourses into the alluvial fan. As indicated, the alluvial fans provide for groundwater recharge.*

- *Wetlands are associated with the watercourses to the east becoming more extensive lower down the slope. A buffer of 32 m from the edge of the wetlands and the extent of the alluvial fan (not distal reaches) are recommended as constraints to the development of the mine. The delineation of these features have however been overlaid on the initial layout and a revised figure should be provided indicating the extent of the freshwater features and buffers as an overlay on the current preferred layout, particularly for southern section which was not part of the initial layout. The excavation is not located within the current preferred layout.*
- *The proposed layout in the Basic Assessment Report/EMPr includes the existing mining footprint. A stormwater trench has been provided for around the western perimeter of the site which is supported. It must be ensured that the exit point of the stormwater trench allows for dissipation/dispersion of the water to prevent channel erosion and promote the current functioning of the watercourses and wetlands. The proposed stormwater management system must be assessed by the aquatic specialist, as stormwater management was not addressed in the aquatic biodiversity screening assessment.*
- *CapeNature recommends that a fine scale map should be provided indicating the current extent of mining, the proposed mining expansion area (and alternatives) and freshwater biodiversity constraints as identified by the specialist study.*

1.4 Relevant Legislation

The protection of water resources is essential for sustainable development and therefore many policies and plans have been developed, and legislation promulgated, to protect these sensitive ecosystems. The proposed project must abide by the relevant legislative requirements. Table 1 below shows an outline of the environmental legislation relevant to the project.

Table 1: Relevant environmental legislation

Legislation	Relevance
South African Constitution 108 of 1996	The constitution includes the right to have the environment protected
National Environmental Management Act 107 of 1998	Outlines principles for decision-making on matters affecting the environment, institutions that will promote co-operative governance and procedures for coordinating environmental functions exercised by organs of state.
Environmental Impact Assessment (EIA) Regulations	The 2014 regulations have been promulgated in terms of Chapter 5 of NEMA and were amended on 7 April 2017 in Government Notice No. R. 326. In addition, listing notices (GN 324-327) lists activities which are subject to an environmental assessment.

The National Water Act 36 of 1998	Chapter 4 of the National Water Act addresses the use of water and stipulates the various types of licensed and unlicensed entitlements to the use of water. Also, according to the Department of Water and Sanitation (DWS), any structures within a 500-metre radius from the boundary of a wetland constitutes a Section 21(c) and (i) water use and as such requires a water use licence.
General Authorisations (GAs)	Any uses of water which do not meet the requirements of Schedule 1 or the GAs, require a license which should be obtained from the Department of Water and Sanitation (DWS). Government Notice R509 of 2016 was issued as a revision of the General Authorisations (No. 1191 of 1999) for section 21 (c) and (i) water uses (impeding or diverting flow or changing the bed, banks or characteristics of a watercourse) as defined under the NWA. Determining if a water use licence is required is associated with the risk of impacting on that watercourse. A low risk of impact could be authorised in terms of a General Authorisations (GA).
National Environmental Management: Biodiversity Act No. 10 of 2004	This is to provide for the management and conservation of South Africa's biodiversity through the protection of species and ecosystems; the sustainable use of indigenous biological resources; the fair and equitable sharing of benefits arising from bioprospecting involving indigenous biological resources; and the establishment of a South African National Biodiversity Institute.
Conservation of Agricultural Resources Act 43 of 1967	To provide for control over the utilization of the natural agricultural resources of the Republic in order to promote the conservation of the soil, the water sources and the vegetation and the combating of weeds and invader plants; and for matters connected therewith.

1.5 Scope of Work

The Scope of Work in accordance with the specific Terms of Reference are described below:

Contextualisation of study area

- ✓ Contextualization of the study area in terms of important biophysical characteristics and the latest available aquatic conservation planning information (including but not limited to vegetation, CBAs, Threatened ecosystems, any Red data book information, NFEPA data, broader catchment drainage and protected areas).

- ✓ Desktop delineation and illustration of all watercourses within and surrounding the study area utilising available site-specific data such as aerial photography, contour data and water resource data.
- ✓ A risk/screening assessment of the identified aquatic ecosystems to determine which ones will be impacted upon by the proposed development and therefore require groundtruthing and detailed assessment.

Delineation and classification

- ✓ Ground truthing, infield identification, delineation and mapping of any potentially affected aquatic ecosystems in terms of the Department of Water and Sanitation (DWAF 2008) Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas.
- ✓ Field delineation must follow the accepted national protocol and should result in a map that includes the identified boundary and the field data collection points (which should include at least one point outside the wetland or riparian area), and a report that explains how and when the boundary was determined.
- ✓ Classification of the identified aquatic ecosystems in accordance with the, 'National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa' (Ollis et al. 2013) and WET-Ecoservices (Kotze et al. 2009).
- ✓ Description of the identified watercourses with photographic evidence.

Aquatic Assessment

- ✓ Conduct a Present Ecological State (PES), functional importance assessment and Ecological Importance and Sensitivity (EIS) assessment of the delineated wetland habitats, utilising the latest tools, such as:
  - → Level 2 WET-Health tool (Macfarlane et al., 2009/2018) – PES
  - → WET-Ecoservices (Kotze et al., 2009/2018) and/or the Wetland EIS assessment tool of Roundtree and Kotze (2013). - Functional assessment
- ✓ Conduct a Present Ecological State (PES) and Present Ecological Importance and Sensitivity (EIS) assessment of the delineated river/riparian habitats, utilising:
  - → Qualitative Index of Habitat Integrity (IHI) tool adapted from (Kleynhans, 1996) – PES
  - → DWAF (DWS) River EIS tool (Kleynhans, 1999) - EIS
- ✓ Indicate the Recommended Ecological Category (REC) of the potentially impacted aquatic ecosystems.

Impact Assessment

- ✓ Identification, prediction and description of potential impacts on aquatic habitat during the construction and operational phases of the project. Impacts are described in terms of their extent, intensity, and duration. The other aspects that must be included in the evaluation are probability, reversibility, irreplaceability, mitigation potential, and confidence in the evaluation.

- ✓ All direct, indirect, and cumulative impacts for each alternative must be rated with and without mitigation to determine the significance of the impacts.

Mitigation and monitoring

- ✓ Recommend actions that should be taken to avoid impacts on aquatic habitat, in alignment with the mitigation hierarchy, and any measures necessary to restore disturbed areas or ecological processes.
- ✓ Determination and mapping of any necessary buffer zones with consideration to the *Buffer zone guidelines for rivers, wetlands and estuaries* (Macfarlane & Bredin, 2016).
- ✓ Rehabilitation guidelines for disturbed areas associated with the proposed project and monitoring.

2 DESKTOP ASSESSMENT

Mapping the locality of aquatic habitat is essential for classification into the different wetland and river ecosystem types across the country, which in turn can be used with other data to identify aquatic systems of conservation significance. The screening study was informed by the available datasets relevant to water resources, as well as historic and the latest aerial imagery, to develop an understanding of the fluvial processes of the study area. A significant amount of the latest spatial data has been provided through the products of the 2018 National Biodiversity Assessment (NBA). The NBA is the primary tool for monitoring and reporting on the state of biodiversity in South Africa. It is used to inform policies, strategies and actions in a range of sectors for managing and conserving biodiversity more effectively.

2.1 Drainage characteristics

The study area is located within the H50B quaternary catchment of the Breede Water Management Area. It has a mean annual runoff of 44.27 mm/annum. The study area has a mean annual precipitation rate of 400 mm, which is less than half of the mean annual evaporation rate of 1350.40 mm. It is a winter rainfall region and usually receives the highest amount of rain in July, with the least amount in December. The drainage basin in which the site is located drains towards the Nooitgedag River which is a tributary of the Breede River. There are a number of instream irrigation dams within the catchment.

2.2 South African Inventory of Inland Aquatic Ecosystems

In 2018 the national wetland and river dataset, including the 2011 NFEPA data, was updated as part of the National Biodiversity Assessment (SANBI 2018). A South African Inventory of Inland Aquatic Ecosystems (SAIIAE) was established and offers a collection of data layers pertaining to ecosystem types and pressures for both rivers and inland wetlands. National Wetland Map 5 includes inland wetlands and estuaries, associated with river line data and many other data sets within the South African Inventory of Inland Aquatic Ecosystems (SAIIAE) 2018. The South African National Wetlands Map (NWM) provides information on the location, spatial extent, and ecosystem types of estuarine and inland aquatic ecosystems (Van Deventer *et al.*, 2018).

According to the data provided by the South African Inventory of Inland Aquatic Ecosystems (SAIIAE 2018) there is no aquatic habitat within the proposed mining site. The NWM identifies a seep wetland situated south and downslope of the proposed site boundary (Figure 4), and a seep wetland habitat upslope upon the alluvial fans at the base of the mountain. The preferred alternative (Alternative 2) site boundary is in closer proximity to that mapped wetland than the original alternative.

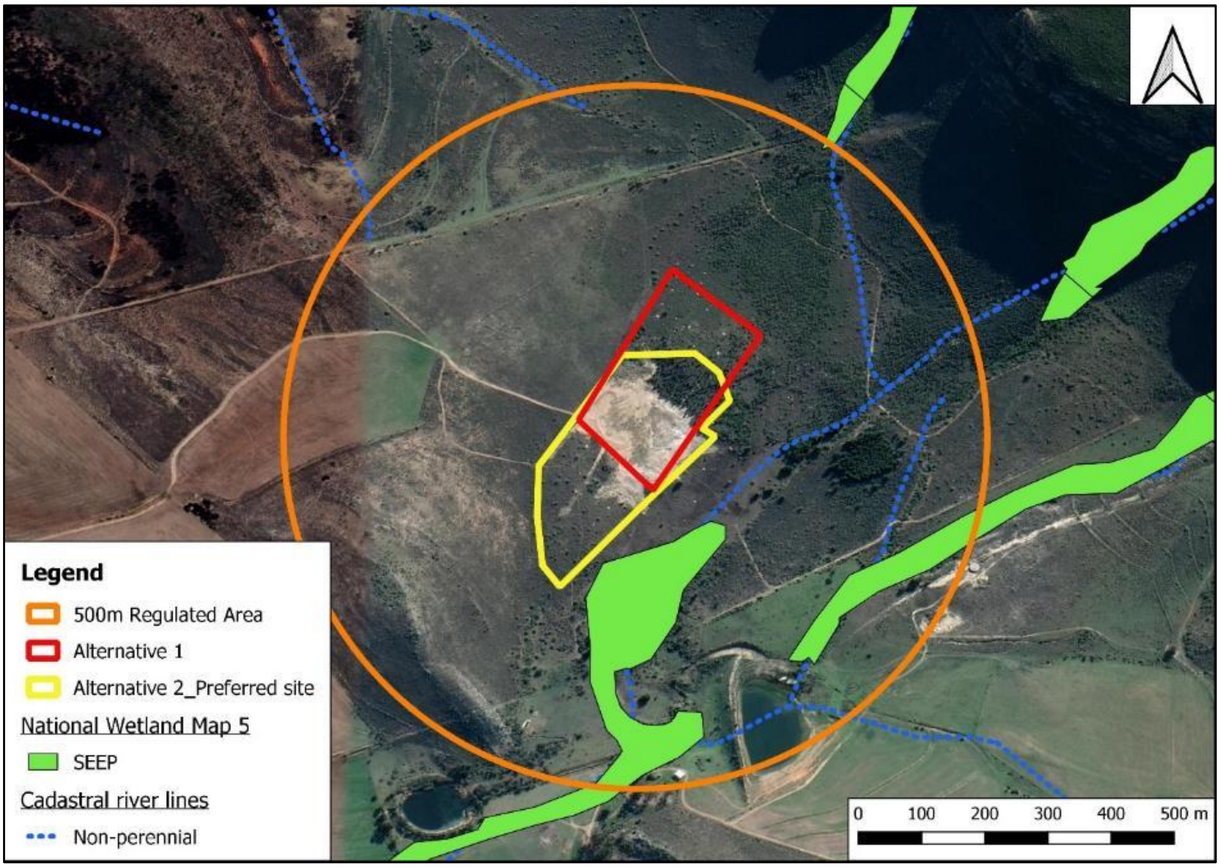

Figure 4:The wetland data of the South African Inventory of Inland Aquatic Ecosystems (CSIR 2018)

2.3 Geology and vegetation

The site substrate consists of course sand. Geologically the area is upon the Norree Formation which is dominated by phyllite, greywacke quartzite, conglomerate, limestone, dolomite, gritstone , with sandstone materials (Figure 5). The soils are classified as highly erodible. The site lies upon a fractured aquifer resulting in a high ground water recharge rate of 20.96 mm/a.

The vegetation of the study area is categorised by the 2018 vegetation map as Robertson Granite Fynbos and classified as Least Threatened (Figure 6). It is confined to the foothills of the Langeberg mountains covered with a dense proteoid shrubland. However, invasive alien plant species were observed during site investigations. There is a large portion of the site covered in dense Hakea trees which have significantly decrease the biodiversity (Figure 7). Hakea are a declared Category 1b invasive alien species. It releases seeds post-fire and thus explains the increase in density and extent of trees visible in aerial imagery following the 2013 fire.

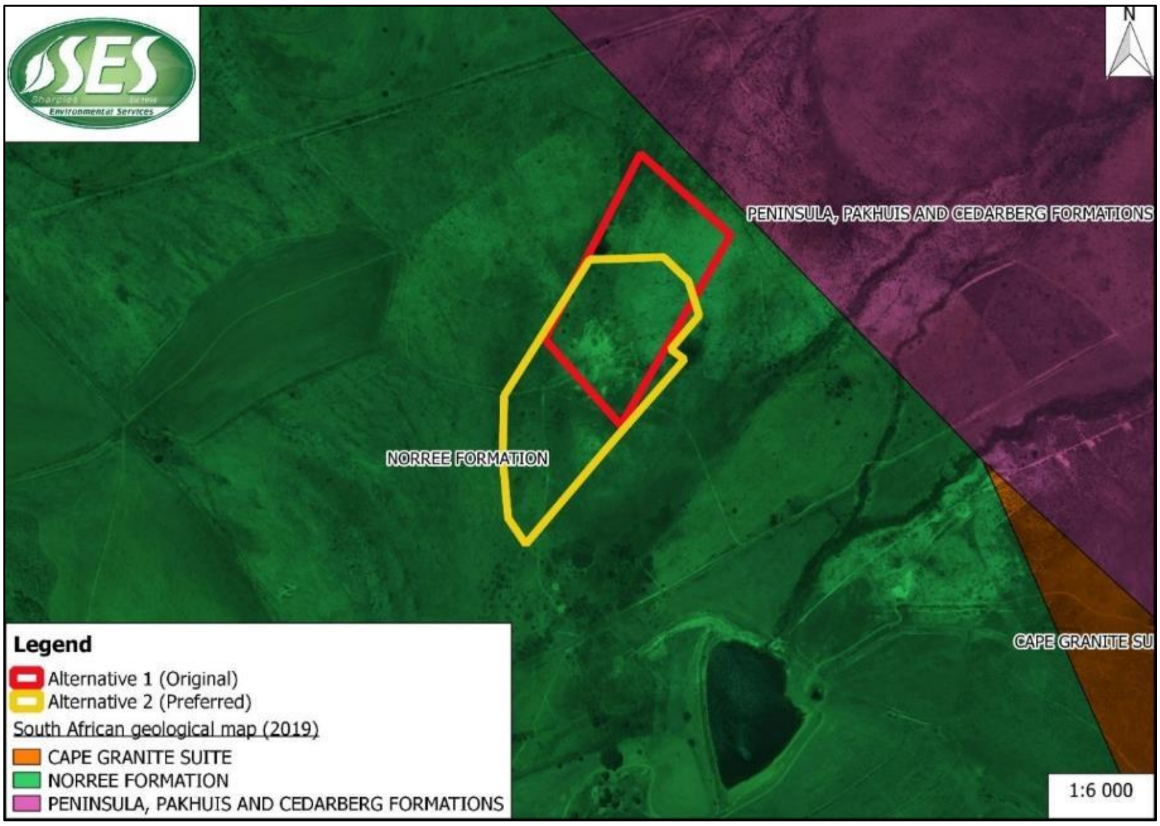

Figure 5:The proposed site in relation to the South African Geological Map (CGS 2019)

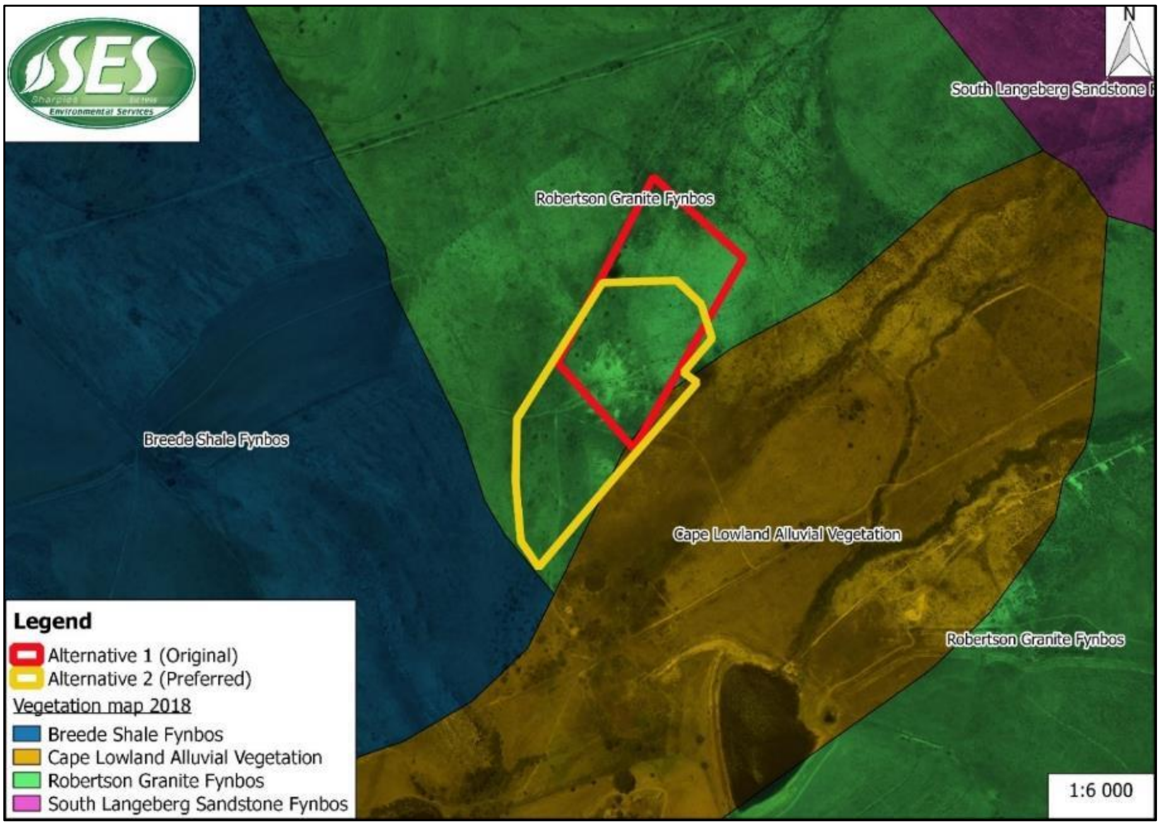

Figure 6:The proposed site in relation to the national vegetation map (SANBI 2018)

Figure 7: Photograph of the alien invasive Hakea trees in a dense stand on the site

2.4 Western Cape Biodiversity Spatial Plan

The Western Cape Biodiversity Spatial Plan (WCBSP) is recognised by both the Department of Environmental Affairs and South African National Biodiversity Institute. The primary purpose of a map of Critical Biodiversity Areas and Ecological Support Areas is to guide decision-making about where best to locate development. Critical Biodiversity Areas (CBA’s) are required to meet biodiversity targets. These areas have high biodiversity and ecological value and therefore must be kept in a natural state without further loss of habitat or species. Low-impact, biodiversity sensitive land uses are the only land uses allowed in CBA’s. Critically Endangered (CR) ecosystems, critical corridors for maintaining landscape connectivity and areas required to meet biodiversity pattern targets, are included in CBA’s. The WCBSP made a distinction between areas likely to be in a natural condition (CBA1) and areas that could be degraded (CBA2). Ecological Support Areas (ESA’s) are not essential for meeting biodiversity targets but are important as they support the functioning of CBA’s and Protected Areas (PA’s). ESA’s support landscape connectivity, surrounds ecological infrastructure that provide ecosystem services, and strengthen resilience to climate change. These areas include Endangered vegetation; water source and recharge areas; and riparian habitat around rivers and wetlands. The WCBSP also made a distinction between ESA’s in a functional condition (ESA1) and degraded areas in need of restoration (ESA2).

The BSP data categorises the habitat on the proposed site as ESA1 for groundwater recharge ecological processes (Figure 8). The area of soil disturbance within the site is classified as ESA2, potentially due to the depression in the landscape caused by excavations. Bordering the south eastern area is CBA1 terrestrial habitat with CBA1 wetland habitat mapped downslope. The Alternative 2 preferred site encroaches into CBA mapped wetland habitat. According to the BSP, there should not be any further habitat loss within the CBA1 areas.

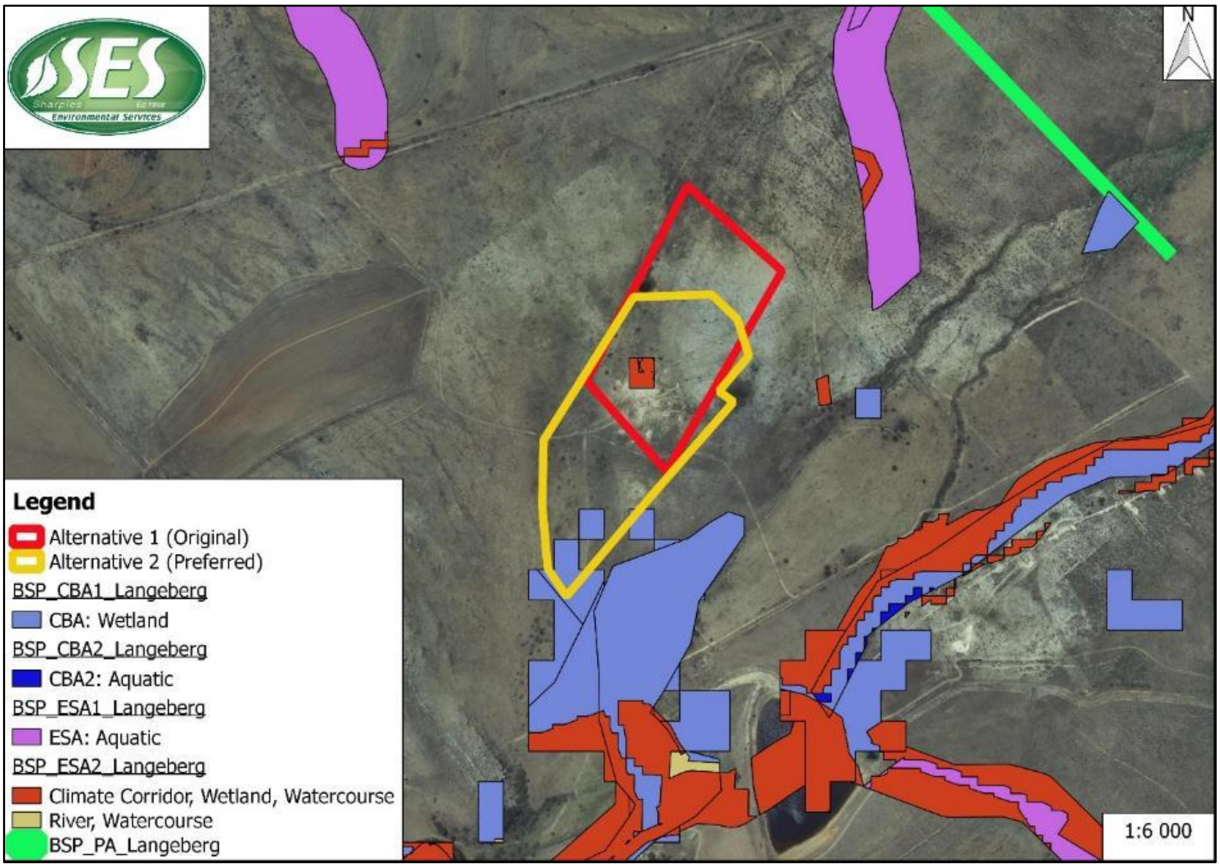

Figure 8: The study site in relation to features identified by the WCBSP (Pence, 2017).

2.5 Historic impacts

Historical aerial photography and Google satellite imagery was analysed to develop an understanding of the change in land uses within the study area over time. This is important in any wetland assessment as wetland health is defined as a measure of the deviation of wetland structure and function from the wetland's natural reference condition (Macfarlane *et al*. 2009). Catchment and site-specific impacts are important for determining a baseline of the current status quo.

Figure 9 is an enhanced image from an aerial photograph taken in 1960. It shows that the area was already being utilised for agricultural purposes but cultivated land has since increased in extent. However, the site itself seems undisturbed. The quality of the photography is limited but there may be evidence of a small circular area of unvegetated sand. The feature may be from historic sand removal or the excavated livestock dam, but this is undetermined. The 2006 Google imagery clearly shows excavations in this area of the site, as well as gravel roads and the small dam. In 2013 it is evident that the area was burnt by a wildfire and in 2016 the alien invasive Hakea trees are noticeable. In 2017 the excavated area of the site has increased significantly (approximately half the site is disturbed by sand excavation) to the present size. Figure 10 shows the excavated area.

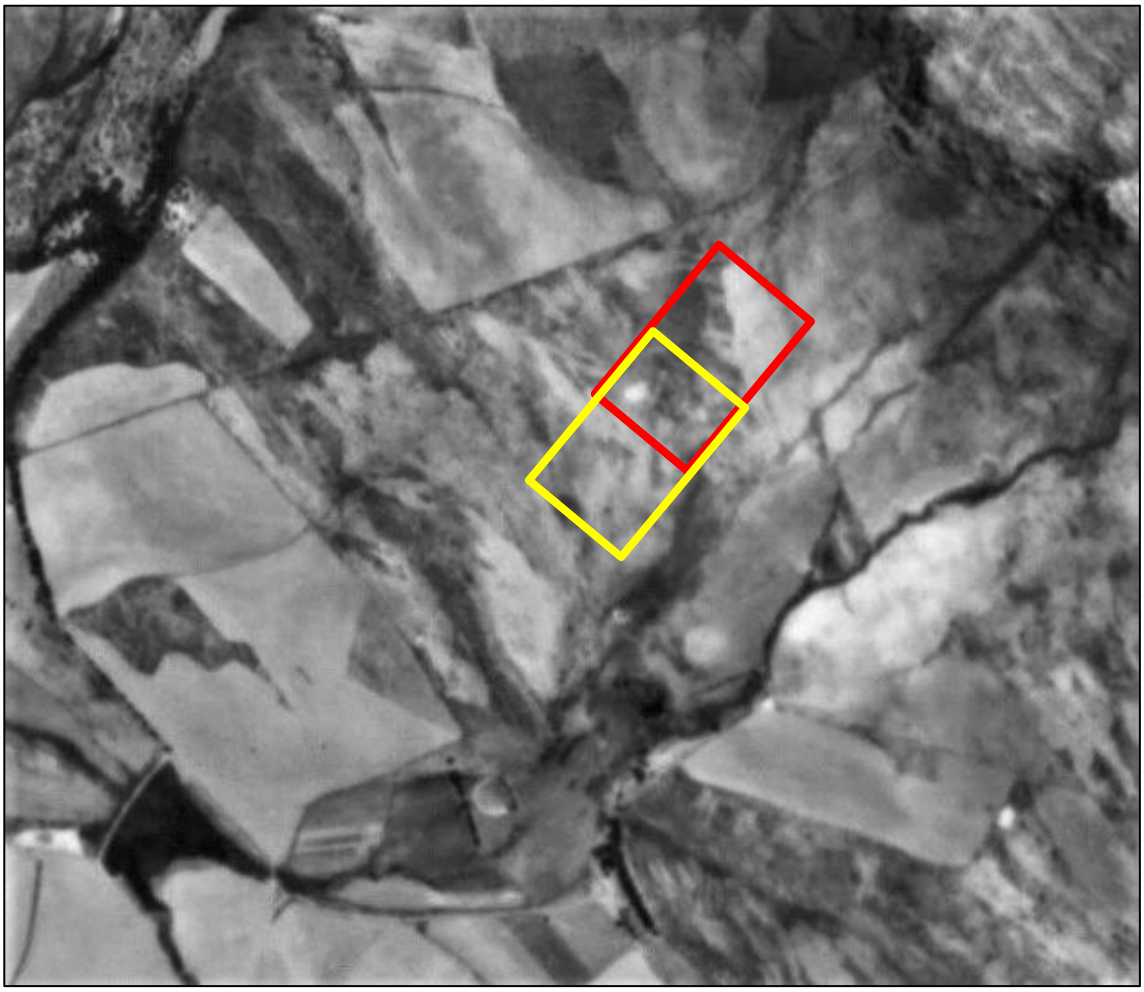

Figure 9: Aerial photography from 1960 of the study area, showing the undisturbed site and agricultural activities surrounding the site. The site is indicated by the red rectangle.

Figure 10: Photograph of the most recently excavated area

3 APPROACH AND METHODS

3.1 Desktop Assessment Methods

- The contextualization of the study area was undertaken in terms of important biophysical characteristics and the latest available aquatic conservation planning information in a Geographical Information System (GIS). It is imperative to develop an understanding of the regional drainage setting and longitudinal dynamics of the watercourse. The conservation planning information aids in the determination of importance and sensitivity, management objectives, and the significance of potential impacts.
- Following this, desktop delineation and illustration of all watercourses within the study area was undertaken utilising available site-specific data such as aerial photography, contour data and water resource data. Digitization and mapping were undertaken using QGIS 2.18 GIS software.
- These results, as well as professional experience, allowed for the identification of specific watercourses that could potentially be impacted by the activities and therefore required groundtruthing and detailed assessment. The following data sources listed within Table 2 assisted with the assessment.

Table 2: Utilised data and associated source relevant to the proposed project

Data	Source
Google Earth Pro™ Imagery	Google Earth Pro™
DWS Eco-regions (GIS data)	DWS (2005)
South African Vegetation Map (GIS Coverage)	Mucina & Rutherford (2006-2018)
National Biodiversity Assessment Threatened Ecosystems (GIS Coverage)	SANBI (2018)
Geology	Council for Geoscience (2019)
Contours (elevation) - 5m intervals	Surveyor General
NFEPA river and wetland inventories (GIS Coverage)	CSIR (2011)
NEFPA river, wetland and estuarine FEPAs (GIS Coverage)	CSIR (2011)
Western Cape Biodiversity Framework 2017: Critical Biodiversity Areas of the Western Cape.	Pence (2017)
National Wetland Map 5	Van Deventer, et al. (2018)

3.2 Baseline Assessment Methods

- Infield site assessment was conducted on the 24th of August 2020 to confirm the location and extent of the systems identified as likely to be impacted by the proposed project. There are a number of factors which influence the level of impact, such as type of system, position of the system in relation to the project and position the system is located in the landscape. The identified aquatic ecosystems were classified in accordance with the, '*National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa'* (Ollis *et al*. 2013) and *WET-Ecoservices* (Kotze *et al*. 2009).
- Infield delineation was undertaken with a hand-held GPS, for mapping of any potentially affected aquatic ecosystems, in alignment with standard field-based procedures in terms of the Department of Water and Sanitation (DWAF 2008) *Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas*. The delineation is based upon observations of the landscape setting, topography, vegetation and soil characteristics (using a hand-held soil auger for wetland soils).
- Determination of the Present Ecological State (PES), functional importance assessment and Ecological Importance and Sensitivity (EIS) assessment of the delineated wetland habitat.
  - The health/condition or Present Ecological State (PES) of the wetland was assessed using the Level 1 WET-Health assessment tool (Macfarlane *et al.* 2008), which is based on an understanding of both catchment and on-site impacts and the impact that these aspects have on system hydrology, geomorphology and the structure and composition of wetland vegetation.
  - Wetland benefits can be classified into goods/products (directly harvested from wetlands), functions/ services (performed by wetlands), and ecosystem scale attributes. The WET-Ecoservices tool (Kotze *et al*., 2009) is utilised to assess the goods and services that the individual wetlands under assessment provide, thereby aiding

informed planning and decision-making. The tool provides guidelines for scoring the importance of a wetland in delivering each of 15 different ecosystem services (including flood attenuation, sediment trapping and provision of livestock grazing).

- The Ecological Importance and Sensitivity (EIS) of freshwater habitats is an expression of the importance of the water resource for the maintenance of biological diversity and ecological functioning on local and wider scales; whilst Ecological Sensitivity (or fragility) refers to a system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (Kleynhans & Louw, 2007). There Wetland EIS Tool was utilised to determine EIS (Kleynhans, 1999).

- The PES and EIS results then allowed for the determination of management objectives for the potentially impacted aquatic ecosystems. Refer to the Table below and Annexure 12 for a list and description of the tools utilised.

Table 3: Tools utilised for the assessment of water resources impacted upon by the proposed project.

METHOD/TOOL*	SOURCE	REFERENCE	APPENDIX (ANNEXURE)
Delineation of wetland and/or Riparian areas	*A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas.*	(DWAF 2005)	12.1
Classification of wetlands and/ or other aquatic ecosystems	*National Wetland Classification System for Wetlands and other Aquatic Ecosystems in South Africa & WET-Ecoservices*	(Ollis *et al.*, 2013, Kotze *et al.*, 2009)	12.2
Present Ecological State (PES) Assessment (Wetland)	*WET-Health Assessment*	(McFarlane *et al.* 2009)	12.3
Functional Importance Assessment (Wetland)	*WET-Ecoservices Assessment*	(Kotze *et al.*, 2009)	12.4
Ecological Importance & Sensitivity (EIS) Assessment (wetland)	*DWAF Wetland EIS Tool*	(Duthie 1999)	12.5
Present Ecological State (PES) Assessment (River)	*Rapid IHI (Index of Habitat Integrity) tool developed Kleynhans (1996), Modified by DWAF*	(Ecoquat)	12.6
Ecological Importance & Sensitivity (EIS) Assessment (River)	*DWAF EIS tool developed by Kleynhans (1999)*	(Kleynhans, 1999)	12.7

3.3 Impact Assessment Methods

- The approach adopted is to identify and predict all potential direct and indirect impacts resulting from an activity from planning to rehabilitation. Thereafter, the impact significance is determined.

- Impact significance is defined broadly as a measure of the desirability, importance and acceptability of an impact to society (Lawrence, 2007). The degree of significance depends upon three dimensions: the measurable characteristics of the impact (e.g. intensity, extent and duration), the importance societies/communities place on the impact, and the likelihood /

probability of the impact occurring. A methodology for assigning scores to the respective impacts is described in Annexure 12.

- Actions are thereafter recommended to prevent and mitigate the identified impacts on aquatic habitat, in alignment with the mitigation hierarchy, as well as any measures necessary to restore disturbed areas or ecological processes.

3.4 Opportunities and Constraint Analysis

- Regarding any proposed development on the property, a buffer area from the boundary of the aquatic habitat must be determined. The specific size of the buffer zone was determined by a tool developed by Macfarlane and Bredin (2016) called *Buffer zone guidelines for rivers, wetlands and estuaries*, site-based information and professional opinion. The final buffer requirement includes the implementation of practical management considerations/mitigation measures.
- Identify legislation and permit requirements that are relevant to the development proposal from an aquatic perspective.
- Present recommendations of the suitability of the site based on sensitivity analysis.

4 ASSUMPTIONS AND LIMITATIONS

The following assumptions and limitations are relevant:

- Aquatic ecosystems vary both temporally and spatially. Once-off surveys such as this are therefore likely to miss certain ecological information due to seasonality, thus limiting accuracy and confidence.
- Infield soil and vegetation sampling was only undertaken within a specific focal area around the proposed site, while the remaining watercourses were delineated at a desktop level.
- No detailed assessment of aquatic fauna/biota was undertaken.
- The vegetation information provided is based on observation not formal vegetation plots.
- The recommended buffer areas are informed by the site-specific ecological concerns arising from the field survey and based on the assessor’s working knowledge and experience with similar projects. It is assumed that mitigation will be implemented effectively.
- The study does not include groundwater assessment or flood line determination. The potential impacts of the mining on groundwater should be investigated to ensure the protection of water resources. The mine site is located in an area where groundwater recharge processes occur.

5 RESULTS

Following desktop and field analysis of the aquatic habitats, relevant to the boundary of the proposed mining site, the subsequent results were obtained. The aquatic habitats within the area of the proposed project were identified and mapped on a desktop level utilising available data, following which, the infield site assessment (conducted on the 24th of August 2020) confirmed the location and extent of these systems (Figure 11). Numerous test pits excavated around the site provided additional information on the soil and water table characteristics.

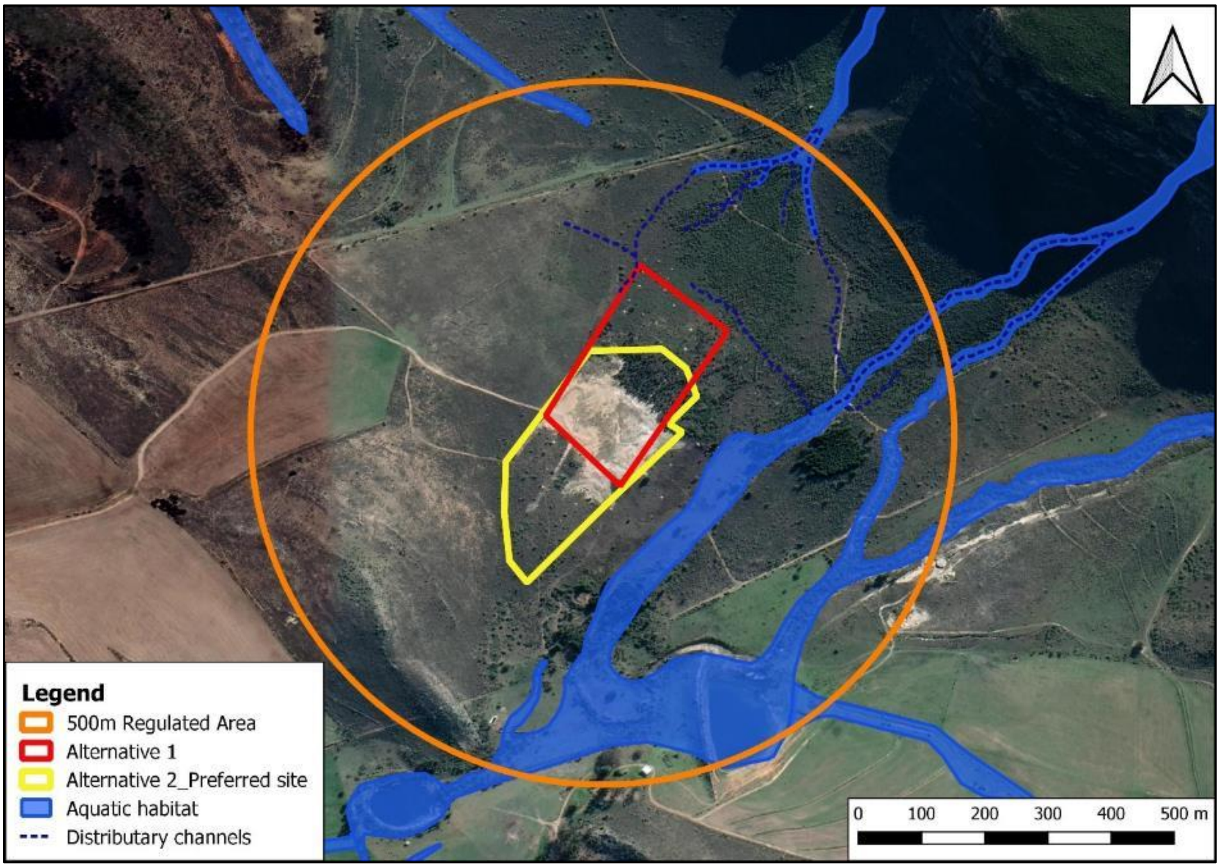

Figure 11: Map showing the assessed watercourses in relation to the sites and the Regulated Area.

It was determined that there is a small dam within the site, likely excavated for livestock drinking water, but it is not a natural feature (Figure 12). The depression was dry during site assessment and visibly artificial in nature. It has revegetated with pioneer weeds and grasses but does also contain some sedges due to the moist soils at the base. This dam is an old watering point which is not providing any wetland services. Its loss as a result of mining will have no impact upon water resources. There were no other surface water features within the site.

Figure 12: Photograph of the excavated depression which was likely an old dam used for livestock water but has since infilled and revegetated

There is, however, a watercourse located downslope and approximately 70 m south east of the proposed sites. This watercourse, as well as the alluvial fan to the north of the site, are fluvial features that may be impacted upon by mining. If an adequate buffer area can be implemented between any activities and these sensitive areas, then it is possible for most impacts to be completely avoided. The watercourses are shown in Figure 13 and described further below.

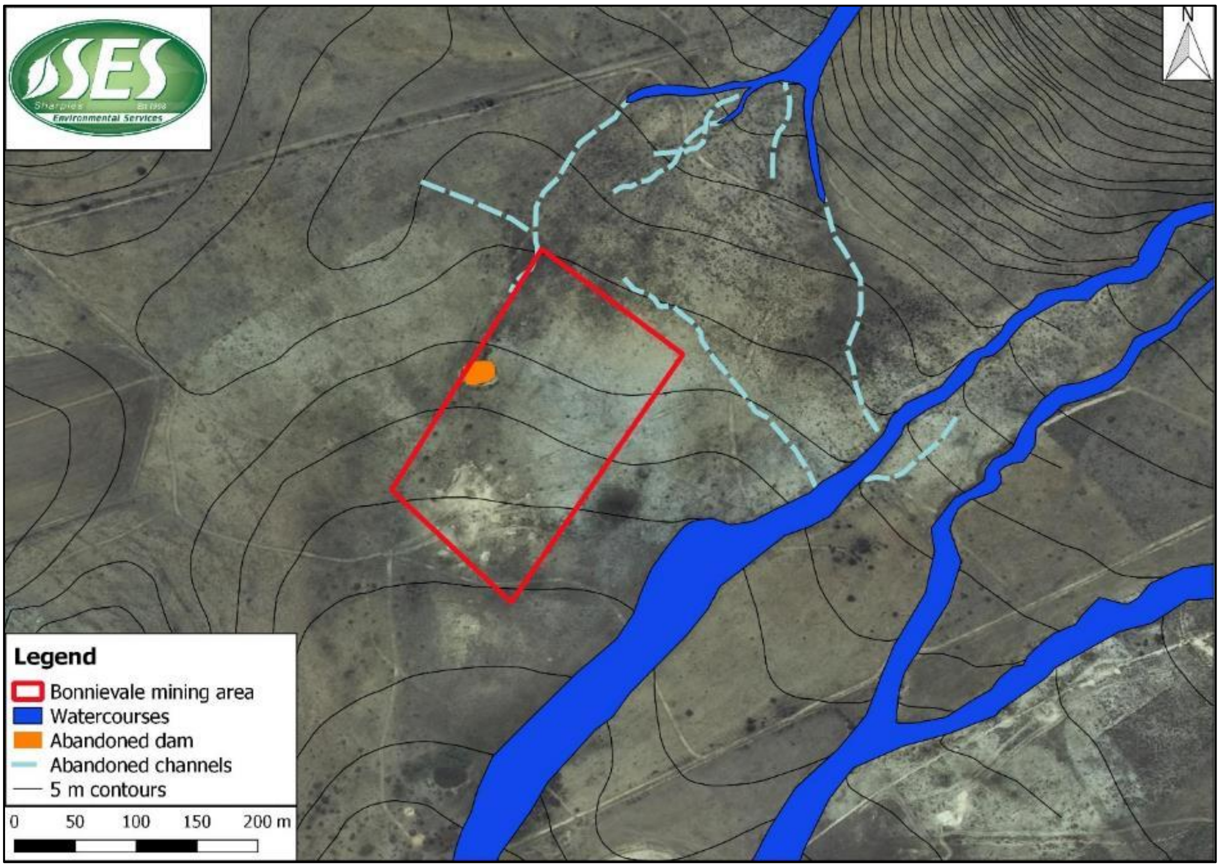

Figure 13: Map showing the small dam within the site and the delineated watercourses surrounding the site (note: this is not mapped using the latest imagery)

The watercourse which flows in a south westerly direction from the mountain, past the eastern side of the proposed site, originates as a non perennial mountain stream and as it loses confinement it develops wetland characteristics (Figure 14). The wetland habitat is also fed by groundwater seepage, but it is rarely inundated. It is vegetated with grass and sedge plant species. The area has been used for livestock grazing but it is in good condition and has not deviated significantly from the reference state.

Figure 14: Photograph of the non perennial watercourse. Arrows showing the direction of flow.

The other fluvial landform near the site is a mountain-front alluvial fan, located to the north, with unconfined flows. An alluvial fan is a conical shaped sediment deposit that occurs where a stream loses confinement at the apex, resulting in deposition. Flows decelerate and spread laterally due to change in gradient, triggering sediment deposition. The fan is characterised by a network of distributary channels, some of which are abandoned. The channels dissipate on the hillslope above the site but there is evidence of abandoned distributary channels on the alluvial fan. It is considered part of the connected fluvial system by contributing water and sediment. There is sediment fining from the apex to distal reaches. The proposed mining sites are located upon the finer sandy soils of the distal reaches (Figure 15).

Alluvial fans play a critical role in groundwater recharge. They allow for groundwater recharge to occur by creating a local aquiclude. Basal trimming by mining may change the local base level by shortening the fan profile. This would have to be confirmed by a groundwater specialist but as a precaution mining should avoid the alluvial fan as far as possible or limit the depth of excavations in proximal areas. Mining may also alter the surface flow pattern over the fan if runoff is diverted into confined flow paths or creates new distributary channels. Lowering of the base level could result in erosion which will modify the water and sediment regime. Therefore, although there are no natural surface water features on site, it is connected to fluvial processes.

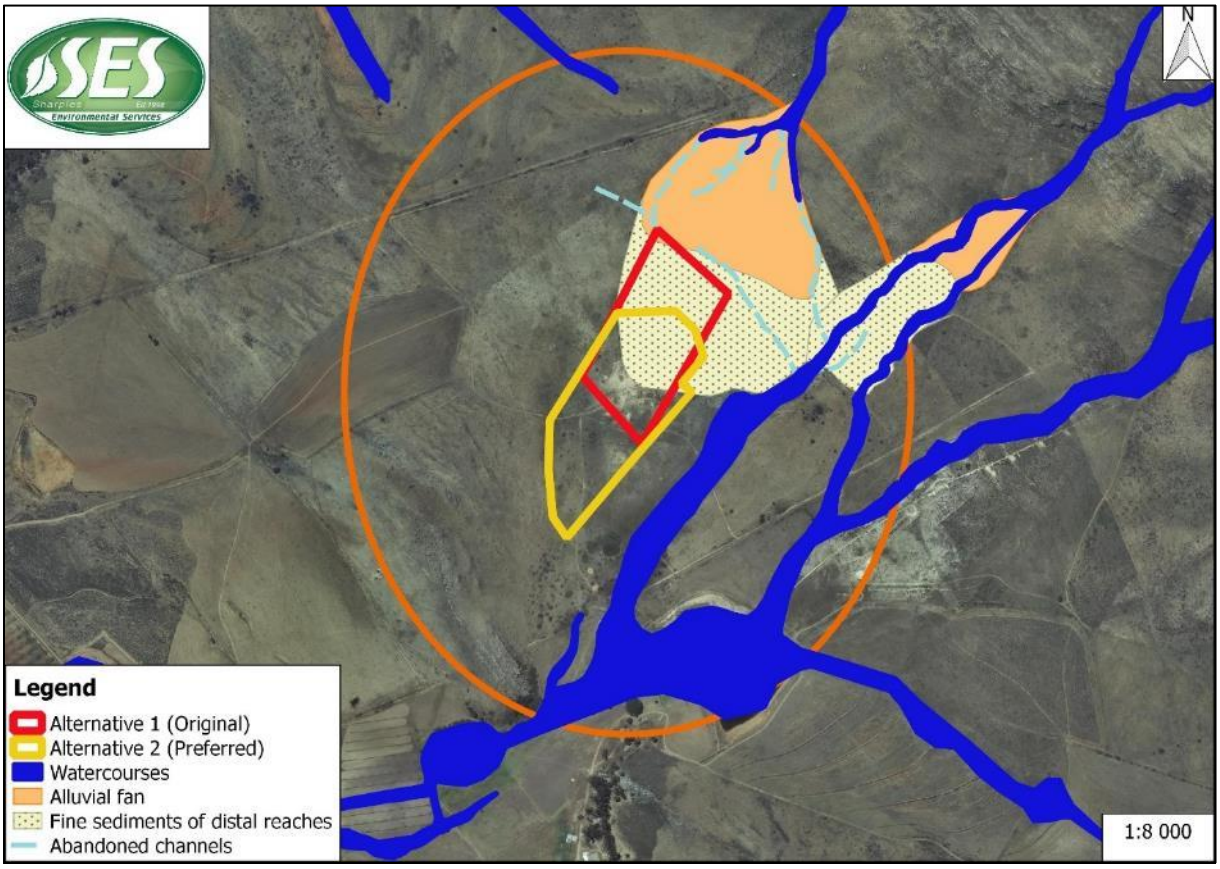

Figure 15: Map of the site in relation to the alluvial fans

6 POTENTIAL IMPACTS

Aquatic ecosystems are particularly vulnerable to human activities and these activities can often result in irreversible damage or longer term, cumulative changes. The significance of an impact to the environment or ecosystem can only be assessed in terms of the change to ecosystem services, resources and biodiversity value associated with that system or component being assessed. The approach adopted is to identify and predict all potential direct and indirect impacts resulting from an activity from planning to rehabilitation. Thereafter, the impact significance is determined. If the identified freshwater habitats are excluded from the mining area, and the buffer adopted, there will be no direct impacts.

6.1 Disturbance / loss of aquatic habitat

The mining will require land clearance, excavations, and soil movement, upslope of the wetland. There is potential for aquatic habitat loss if the wetland areas are not avoided and allocated a buffer zone. The disturbance or loss of aquatic vegetation and habitat refers to the direct physical destruction or disturbance of aquatic habitat caused by vegetation clearing, disturbance of wetland habitat, encroachment and colonisation of habitat by invasive alien plants. The wetland could be disturbed by various activities, associated with readying the mining area, if encroachment occurs. The project will require the majority of vegetation on the hillslope to be cleared. The machinery, vehicles and workers (i.e. turning areas) needed to construct the roads and laydown areas will alter the catchment land cover. However, if the No Go areas and buffers are adhered to there will be very low potential disturbance to the aquatic habitats.

Decommissioning may require soil movement in order to, as far as possible, return the landscape to a similar pre-mining topography. It may require the placement of erosion control measures, revegetation of bare ground areas, and alien plant removal. Therefore, the impacts of the machinery and workers needed to undertake the rehabilitation will be the same as those anticipated during the commencement and operational phases. If the recommended No Go areas of this report are adhered to, and the rehabilitation is successful, there should not be any significant impact upon the wetland.

6.2 Sedimentation and erosion

Sedimentation and erosion refers to the alteration in the physical characteristics of wetlands and rivers as a result of increased turbidity and sediment deposition, caused by soil erosion and earthworks that are associated with construction activities, as well as instability and collapse of unstable soils during project operation. These impacts can result in the deterioration of aquatic ecosystem integrity and a reduction/loss of habitat for aquatic dependent flora & fauna. Soil movement and the creation of dust near the wetland during the clearance of the area for mining may result in sedimentation. This may cause the burying of aquatic habitat and also cause aquatic faunal fatalities. Vegetation clearance and construction of any roads on the hillslope may lead to sediment movement.

Ineffective site stormwater management, particularly in periods of high runoff, can lead to soil erosion from confined flows. Formation of rills and gullies from increased concentrated runoff. This increase in volume and velocity of runoff increases the particle carrying capacity of the water flowing over the surface. Soil compaction resulting in reduced infiltration and increased surface runoff together with the artificial creation of preferential flow paths due to construction activities, will result in increased quantities of flow entering the systems. If the buffer areas can be avoided in accordance with the Aquatic Buffer Map, then the wetland may not be impacted upon.

Where soil erosion problems and bank stability concerns initiated but are not timeously and adequately addressed, these can persist throughout the operational phase of the project and continue to have a negative impact on water resources in the study area. Mining of the alluvial fan deposits should be avoided as it could initiate slumping from the material above resulting in gully formation. Decommissioning may require soil movement in order to, as far as possible, return the landscape to a similar pre-mining topography. It may require the placement of erosion control measures, revegetation of bare ground areas, and alien plant removal. Therefore, the impacts of the machinery and workers needed to undertake the rehabilitation will be the same as those anticipated during the construction phase.

6.3 Water Pollution

Water and/or soil pollution cause negative changes in the physical, chemical and biological characteristics of water resources (i.e. water quality). This can result in possible deterioration in aquatic ecosystem integrity and a reduction in, or loss of, species of conservation concern (i.e. rare, threatened/endangered species). The result is only disturbance tolerant species remaining.

Hydrocarbons including petrol/diesel and oils/grease/lubricants associated with construction activities (machinery, maintenance, storage, handling) may potentially enter the wetland by means of surface runoff or through dumping by construction workers. The incorrect positioning and maintenance of the portable chemical toilets and use of the surrounding environment as ablution facilities may result in sewage and chemicals entering the systems. However, the wetland downslope is only seasonally saturated and there is negligible open water within the study area. Therefore, the risk to water quality of any resources is very limited. If the No Go Map is adhered to then water pollution will become highly unlikely to occur.

6.4 Flow Modification

This includes the changes in the quantity, timing and distribution of water inputs and flows within a watercourse. Possible ecological consequences associated with this impact may include: deterioration in freshwater ecosystem integrity, reduction/loss of habitat for aquatic dependent flora & fauna, and a reduction in the supply of ecosystem goods & services. Land clearing and earth works upslope will reduce infiltration rates and increase the surface runoff volume and velocity. Such changes in surface roughness and runoff rates may lead to some rill and gully erosion. Altered water inputs from upslope disturbances as well as modified water distribution and retention patterns may affect the hydrological integrity of water resource. However, the likelihood of this small disturbance activity resulting in any significant hydrological changes is small.

One has to ensure that surface flows are slowed and enter the valley in a diffuse pattern. This will be easy to accomplish due to the gentle gradient and uniform micro-topography of the site, as well as the high infiltration rates of the soils. If the buffer area is not altered and remains vegetated, and the stormwater runoff is managed, the impacts can be avoided and the hydrological regime will not be modified.

6.5 Cumulative Impacts

Cumulative impacts on the environment can result from broader, long term changes and not only as a result of a single activity or development. They are rather from the combined effects of many activities overtime. The impacts of the proposed mining expansion, when assessed on its own, are found to be of Low significance (after mitigation). But, due to increasing demand for construction material and constant expansion of mining areas, the combination of mining impacts for a larger scale area becomes cumulatively more significant. The most effective and proactive solution is sustainable land use planning with a broader spatial and temporal focus. The identification and protection of sensitive aquatic habitat on a catchment scale will minimise the amount of negative cumulative impacts. The proposed mining expansion should avoid sensitive habitat as far as possible and then this proposal will not contribute to any cumulative aquatic habitat loss.

7 IMPACT ASSESSMENT

Impact significance is defined broadly as a measure of the desirability, importance and acceptability of an impact to society (Lawrence, 2007). The degree of significance depends upon three dimensions: the measurable characteristics of the impact (e.g. intensity, extent and duration), the importance societies/communities place on the impact (or resource being affected), and the likelihood / probability of the impact occurring. The impact significance of the mine alternatives was determined for each potential impact of the project (Table 4 & 5). The significance weightings (see methodology in Annexure 12) for each potential impact are as follows:

- <30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop the area),
- 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
- >60 points: High (i.e. where the impact must have an influence on the decision process to develop the area).

The No-Go Alternative will have no impact upon aquatic biodiversity. The assessment of impacts 'with mitigation' is considered as the best case scenario and assumes that all of the mitigation measures within this report and the EMPr will be successfully implemented. However, assessment under the category 'without mitigation' measures assumes a worst case scenario involving the poor implementation of construction mitigation, bare minimum incorporation of recommended design mitigation, poor operational maintenance, and poor onsite rehabilitation.

Both mining Alternatives scored a Low impact rating, and either is acceptable, after the adoption of mitigation measures. Alternative 2 has a slightly larger footprint and is in closer proximity to the wetland. Therefore, Alternative 1 scored marginally better, and is the least likely site to impact upon aquatic biodiversity (Tables 4 and 5).

It was determined that the most severe potential impacts associated with the mining will likely be erosion and sedimentation. It is important for surface runoff to be managed to prevent this. Mitigation can easily avoid most impacts. Therefore, with mitigation, stormwater management, and the application of the buffer area, it was determined that the project will have a Low/Very Low impact.

Table 4: Evaluation of potential impacts of the Alternative 1 mining site on the surrounding aquatic habitats

Mitigation	Extent	Duration	Magnitude	Probability	Significance	Confidence
Without Mitigation	Local	Permanent	Minor	Probable	Low	Med-High
With Mitigation	Site only	Long-term	Small	Improbable	Very Low	Med-High
If there is no intrusion into the valley then the potential impacts will be easily managed or avoided. The furthest distance between activities and the wetland must be maintained, and at the least, a buffer zone of 32m should be applied.						

Table 5: Evaluation of potential impacts of the Alternative 2 site on the surrounding aquatic habitats

Mitigation	Extent	Duration	Magnitude	Probability	Significance	Confidence
Without Mitigation	Local	Permanent	Low	Probable	Low	Med-High
With Mitigation	Site only	Long-term	Minor	Improbable	Low	Med-High
Mitigation measures required to ensure the aquatic habitat is not impacted by the mining are easy to implement. For example, the set back line must be clearly visible and demarcated. The monitoring of the mining activities is essential to ensure the mitigation measures are implemented.						

8 MITIGATION

The mitigation of negative impacts on biodiversity and ecosystem goods and services is a legal requirement for authorisation purposes and must take on different forms depending on the significance of the impact and the specific area being affected. Mitigation measures related to the impacts associated with the project activities are intended to augment standard/generic mitigation measures included in the project-specific Environmental Management Programme (EMPr). Mitigation requires the adoption of the precautionary principle and proactive planning that is enabled through a mitigation hierarchy (Figure 16). Its application is intended to strive to first avoid disturbance of ecosystems and loss of biodiversity, and where this cannot be avoided altogether, to minimise, rehabilitate, and then finally offset any remaining significant residual negative impacts on biodiversity (DEA 2013).

Following the decommissioning and rehabilitation of the mine, with the implementation of the recommended mitigation measures, there will be no residual negative impacts. Therefore, offsets are not required as the impacts will be avoided or minimised sufficiently. The following sections detail the recommended mitigation and monitoring efforts.

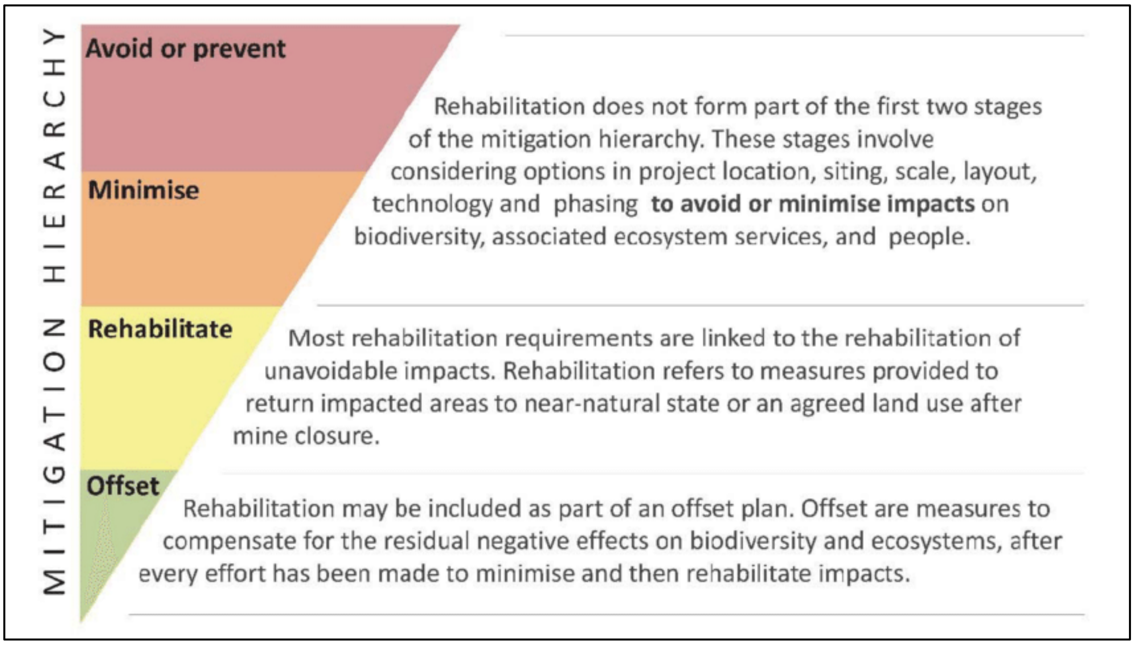

Figure 16: Diagram illustrating the 'mitigation hierarchy' (after DEA et al., 2013)

The mitigation of impacts must focus on managing the runoff and introducing it responsibly into the receiving environment.

8.1 Aquatic Buffer Zones

Aquatic buffer zones are designed to act as barriers between human activities and sensitive water resources in order to protect them from adverse negative impacts. Buffer zones associated with water resources have been shown to perform a wide range of functions and have therefore been adopted as a standard measure to protect water resources and associated biodiversity. An aquatic impact buffer zone is defined as a zone of vegetated land designed and managed so that sediment and pollutant transport carried from source areas via diffuse surface runoff is reduced to acceptable levels (Macfarlane and Bredin 2016). An important component of these buffers is that they represent minimum setbacks from the watercourse. Functions such as stormwater attenuation and roads must lie outside of this setback area. Demarcations are to remain until construction and rehabilitation is complete.

It is recommended that an aquatic buffer zone be adopted between the mining area and the watercourse to the south east of the site (Figure 17). The furthest distance between activities and the watercourse must be maintained, and at the least, a buffer zone of 32m should be applied (Figure 18). If there is no intrusion into the buffer, then the potential impacts will be easily managed or avoided.

Maintenance of the aquatic habitat and buffer area must be implemented for it to remain effective. Apart from erosion control and alien invasive plant eradication, the encroachment of any infrastructure or vehicles must be prevented. The stormwater management infrastructure must be designed to ensure the runoff from the site is not highly concentrated before entering the buffer area. The volume and velocity of water must be reduced through discharging the surface flow at multiple locations surrounding the site, preventing erosion.

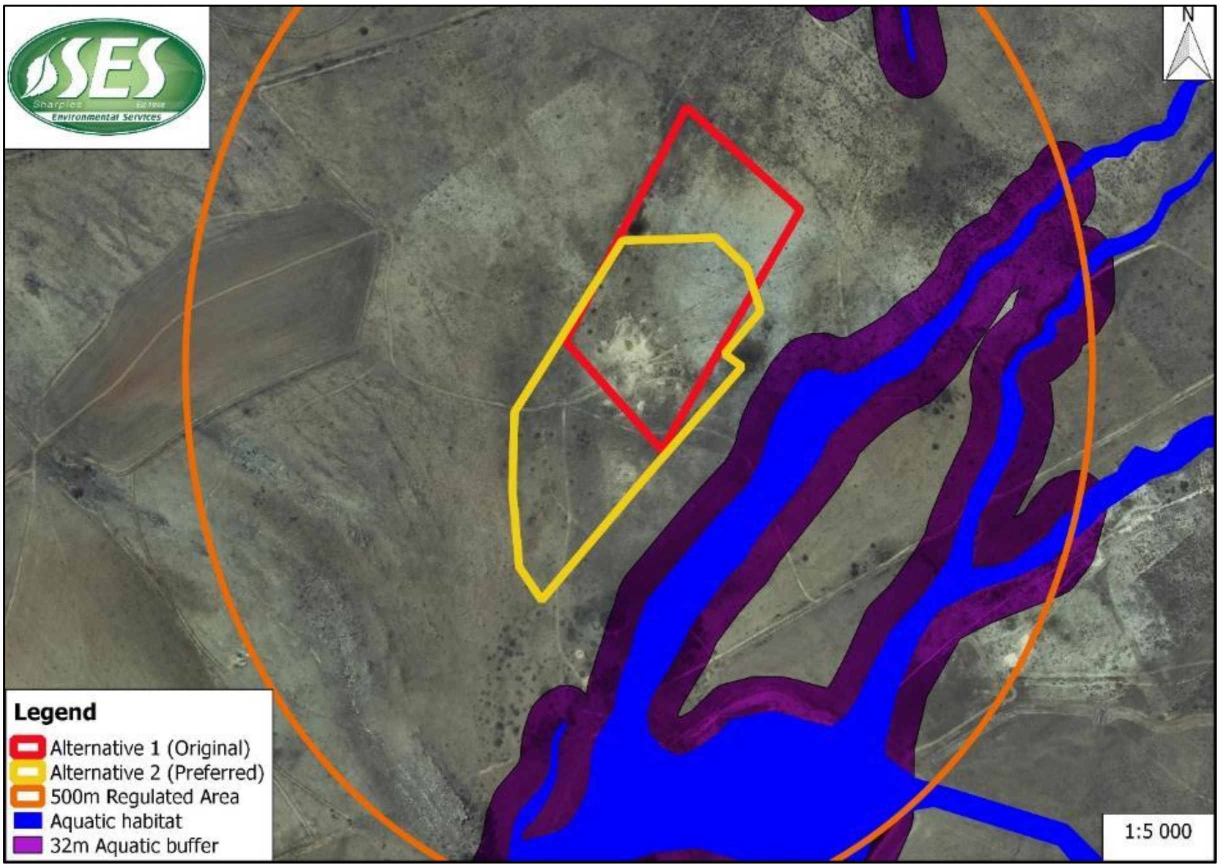

Figure 17: Map showing the Regulated Area around the sites in relation to the recommended aquatic buffer

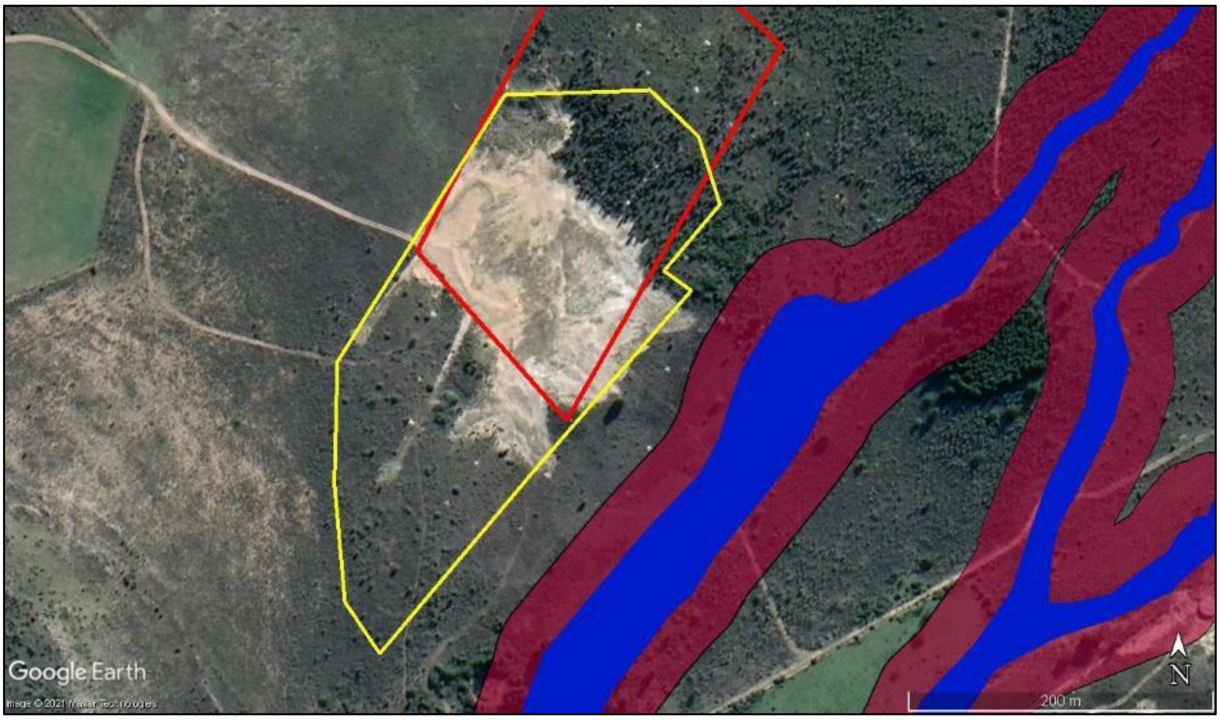

Figure 18: Google satellite imagery (2021) map showing the site in relation to the recommended aquatic buffer area and existing soil disturbance

The assessment of groundwater is not within the scope of this report. However, due to the importance of groundwater recharge processes within the alluvial fans, it is recommended that activities avoid these areas, and that mining does not compromise this ecological function.

Monitoring implementation and management of the final buffer areas should be undertaken throughout the duration of mining activities to ensure that the effectiveness of the final buffer zone areas is maintained, and that management measures are appropriately implemented. Regular inspections during the operational phase should also be undertaken to ensure that functions are not undermined by inappropriate activities. It is also recommended that a stormwater management plan be developed to maintain or mimic the natural runoff as well as prevent the wash-off of pollutants to receiving waters.

8.2 Recommended mitigation measures

Any potential risks must be managed and mitigated to ensure that no deterioration to the water resource takes place. Standard management measures should be implemented to ensure that any on-going activities do not result in a decline in water resource quality. Consideration should also be given to the rehabilitation of watercourses. Mitigation measures related to the impacts associated with the mine activities are intended to augment standard/generic mitigation measures included in the project-specific Environmental Management Programme (EMPr). The following actions are recommended:

- The boundary of the buffer zone must be clearly demarcated (e.g. painted wooden stakes 1m above ground at 10m intervals). There shall be no unauthorised entry, litter, stockpiling, dumping or storage of equipment or materials within the demarcated "no go" areas.
- Before any work commences, sediment control/silt capture measures (infiltration trench/berm) must be installed downslope of the active working areas. The containment areas must be regularly checked and maintained (de-silted to ensure continued capacity to trap silt) and repaired where necessary.
- Where possible, topsoil removed during the mining phase must be conserved and used in the rehabilitation. It can potentially be used to create the stormwater berms and then replaced following decommissioning.
- Stockpiles must not be located within 50 metres of the wetland, dam, and must avoid the buffer area. The furthest threshold must be adhered to. Where necessary, erosion control measures including silt fences, low soil berms and/or shutter boards must be put in place around the stockpiles to limit sediment runoff from stockpiles. Alternatively, the exposed slopes must drain into small temporary stormwater and silt traps/ponds.
- All inactive mining areas/ bare slopes and surfaces which are exposed to the elements during/following clearing and earthworks must be protected against erosion using earthen berms spaced along contours at regular intervals. Structures such as these must be located outside of aquatic buffer areas.

- Prevent any potential sources of pollution from entering the surrounding environment (e.g. litter, hydrocarbons from vehicles & machinery, etc.) and any solid domestic waste must be removed and disposed of offsite. Vehicles must be maintained to prevent leaks.
- If hazardous materials are present, regular routine inspections of pollution control measures and areas containing hazardous materials should be carried out by a suitably qualified person. An emergency response plan must be developed for personnel to mobilise quickly in the event of spillage to reduce the environmental effects of an oil or chemical spill.
- All disturbed areas beyond the construction site that are intentionally or accidentally disturbed during the mining phase must be rehabilitated immediately to the satisfaction of the ECO. All disturbed areas must be prepared and then re-vegetated to the satisfaction of the ECO. Erosion control measures such as earthen berms, logs, sand bags and biodegradable silt fences must generally be installed prior to re-vegetation.
- Erosion features that have developed due to construction within the aquatic habitat due to the project are required to be stabilised. This may also include the need to deactivate any erosion headcuts/rills/gullies that may have developed.
- Rehabilitation of the area should be planned to promote free drainage, as far as possible, and to minimise or eliminate concentration of storm water. It is important that the soils are stabilised during decommissioning.
- Rehabilitation must, as near as possible, return the landscape topographical profile to pre-disturbance form and vegetation. However, this may not be entirely possible as the sand mining operation will cause a depression of the soil surface. The void may create a ponding effect for precipitation and incoming runoff, especially if the water is not diverted away. Due to the high soil infiltration rate, it may not require an outlet. The likelihood of overflow from the void and consequential impacts on the receiving environment can be low. In this instance, erosion and sediment controls to the active mine domain areas may not be necessary. However, should an outlet be necessary, it must not concentrate flow and result in erosion.
- Implement as many closure measures as possible during the operational phase instead of waiting for decommissioning.
- The area must be maintained through alien invasive plant species removal and, where possible, the establishment of indigenous vegetation cover to stabilise soils.
- Vegetation can be used for controlling runoff, stabilising erosion and trapping sediment. Bare ground should be re-vegetated during decommissioning. Grazing of newly established vegetation should not be contemplated for the first two years, unless growth is unusually rapid. By this time, plants are strong enough to resist trampling and their root systems are sufficiently developed to prevent plants being pulled completely out of the ground by grazing stock.

8.3 Stormwater Management Plan

Stormwater management should focus on introducing runoff responsibly into the receiving environment. The stormwater flows must enter the buffer and wetland areas in a diffuse flow pattern, without sediment and pollutants. To achieve these objectives a detailed Stormwater Management Plan (SWMP) must be prepared prior to commencement.

The concentrated surface run-off flowing in the drainage lines on the mountain slope infiltrates the ground at the foothills. Any surface water from the mountain generally disperses upslope of the study area and should not have a significant effect on the mining of sand, and visa versa. There is potential for localised surface runoff from direct rainfall to affect the mining area, however, this too will largely infiltrate into the sandy soils. Therefore, with appropriate management, natural groundwater recharge can easily be maintained and there is no reason for stormwater to impact the site or the wetland.

It is recommended that stormwater runoff be diverted away from the site and the wetland downslope. It must not be channelled directly into the wetland. This strategy can be achieved by implementing berms – a.) to divert clean water away from the active working area, and b.) to contain any silt-laden runoff from the mining area (Figure 19). This will prevent excessive amounts of sediment from entering the surrounding environment and encourage infiltration. The design and location of these berms will depend on the active mining area, but the following overall strategy should be implemented:

- A berm upslope of the active footprint area to divert clean water runoff away from the active area (this will limit the volume of surface water runoff that may accumulate against the downslope berm).
- A berm to be established directly downslope of the active footprint area to contain affected water runoff from the active area.

A similarly designed trench may also manage the stormwater but it does concentrate flows. A water and sediment detention basin should be constructed at the end of stormwater berm or trench to promote infiltration and evaporation of the episodic runoff prior to it leaving the study area. The small, intermittent volumes of stormwater can be collected by shallow pool/ earthen ridges. These structures need not have a large footprint and can be shallow. The measures proposed in this storm water management plan are conceptual in nature and no calculations with regards to flood peaks and volumes was conducted.

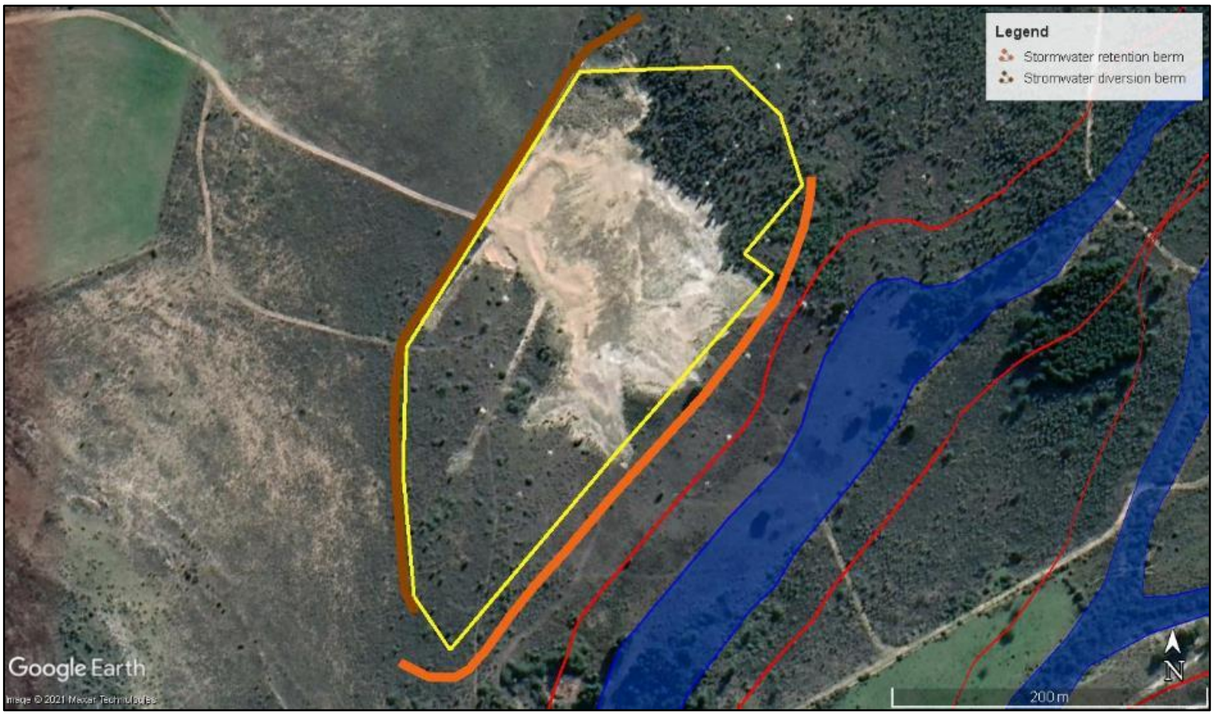

Figure 19: Map showing the recommended stormwater diversion area above the site, and stormwater infiltration berm downslope, in relation to the site using 2021 imagery

Another option is to construct contour banks (also earthen berms) on a slight gradient, at intervals down the slope, in order to intercept excess runoff and guide it away to a retention pond (Figure 20). They must be strongly built and with sufficient capacity to withstand storm rainfall runoff events.

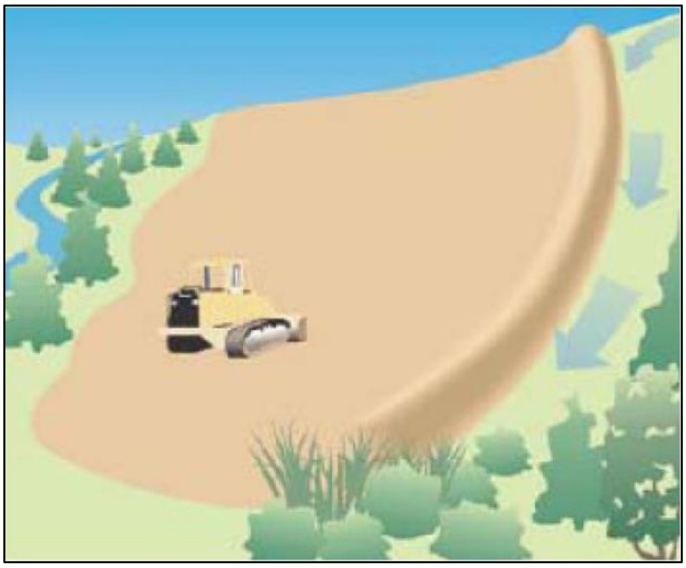

Figure 20: Image depicting the contour berm concept, upslope of the active mining area

The infiltration berm between the site and the buffer zone could also have numerous small outfalls to disperse the runoff, rather than it all being directed into a basin in the west. Therefore, this method would involve open cut-off earth channels to promote infiltration rather than a single continuous earthen bank. The outfalls must be designed to prevent erosion at discharge points.

Outlets should be in the form of multiple smaller storm water outlets rather than a few large outlets in order spread out surface flow and avoid flow concentration and erosion as far as possible. All storm water management infrastructure should be inspected and serviced regularly to ensure design capacity and integrity are maintained. Storm water control measures should be kept clear of obstructions by objects as well as siltation, especially where the velocity of the runoff is induced.

The aim of this stormwater management strategy is to allow the suspended particles in the runoff to settle. During extreme rainfall events, water could overflow from the berm into the buffer area but will contain less suspended particles and thus less silt will be deposited. The infiltration berms/ ponds/ basins/ and sediment traps will also provide for some removal of pollutants (e.g. oils and hydrocarbons), and provide some attenuation by increasing the time runoff takes to reach low points, and reduce the energy of storm water flows. The infiltration measures should recharge of the groundwater table and reduce the risk of erosion. These structures must be outside of buffer areas.

8.4 Monitoring

The monitoring of the activities is essential to ensure the mitigation measures are implemented. Compliance with the mitigation recommendations must be audited by a suitably qualified independent Environmental Control Officer with an appropriately timed audit report. In the case where there is extensive damage to any aquatic system, where rehabilitation is required, a suitably qualified aquatic specialist must audit the site. Photographic records of all incidents and non-compliances must be retained. This is to ensure that the impacts on the aquatic habitat are adequately managed and mitigated against and the successful rehabilitation of any disturbed areas within any system occurs. A monitoring programme shall be in place, not only to ensure compliance with the EMPr throughout the mining phase, but also to monitor any post-operation environmental issues and impacts such as erosion. Recovery of disturbed areas should be assessed for the first 6 months. Any areas that are not progressing satisfactorily must be identified and action must be taken to actively re-vegetate these areas. If natural recovery is progressing well, no further intervention may be required.

Monitoring for non-compliance must also be done on a daily basis by the contractors. It is the contractor's responsibility to continuously monitor the area for newly established alien species during the contract and establishment period, which if present must be removed. Removal of these species shall be undertaken in a way which prevents any damage to the remaining indigenous species and inhibits the re-infestation of the cleaned areas. The contractor should also monitor the mining footprint and general surroundings, weekly, for sedimentation and erosion and implement erosion and sediment control measures immediately where needed.

9 WATER USE AUTHORISATION

Any activity within the regulated area of a wetland or river requires water use authorisation and registration in terms of Chapter 4 of the National Water Act (Act 36 of 1998). The site is within 500m of a wetland and therefore will need to be registered. It has been determined that the project falls within the ambit of General Authorisation. Therefore, the Section 21 (c) and (i) water uses are being applied for through the online eWULAAs system and BGCMA case officer.

The project title on the eWULAAs online portal is 'Sand mining activities within 500m of a wetland, near Bonnievale'. The Department of Water and Sanitation reference number is WU22717. The following water uses are being applied for: :

- Section 21 (c): Impeding or diverting the flow of a watercourse
- Section 21 (i): Altering the bed, banks, course or characteristics of a watercourse

These water uses will be associated with the following activities:

- The mining activities within the regulated area (500m) of the identified wetland

10 CONCLUSION

Sharples Environmental Services cc were appointed by TVM Construction to conduct an independent specialist aquatic impact assessment for the proposed mine. All watercourses within the area of the proposed site were identified, delineated, investigated infield, and screened in accordance with their risk of being impacted upon. No aquatic habitat was identified within the boundaries of the proposed site. A watercourse is located approximately 70 m downslope of the site and an alluvial fan is formed in the northern area. It is recommended that these areas be avoided, and a buffer area is demarcated, to ensure the mining does not impact upon water resources. The proposal has a Low impact significance and is unlikely to cause any significant loss of aquatic biodiversity).

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12 ANNEXURE (METHODOLOGIES)

12.1 Wetland delineation and HGM type identification

Wetland delineation includes the confirmation of the occurrence of wetland and a determination of the outermost edge of the wetland. The outer boundary of wetlands was identified and delineated according to the Department of Water Affairs wetland delineation manual 'A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (DWAF, 2005a). Wetland indicators were used in the field delineation of the wetlands: position in landscape, vegetation and soil wetness (determined through soil sampling with a soil auger and the examining the degree of mottling).

Four specific wetland indicators were used in the detailed field delineation of wetlands, which include:

- The Terrain Unit Indicator helps to identify those parts of the landscape where wetlands are more likely to occur.
- The Soil Form Indicator identifies the soil forms, as defined by the Soil Classification Working Group (1991), which are associated with prolonged and frequent saturation.
- The Soil Wetness Indicator identifies the morphological "signatures" developed in the soil profile as a result of prolonged and frequent saturation.
- The Vegetation Indicator identifies hydrophilic vegetation associated with frequently saturated soils.

According to the wetland definition used in the National Water Act, vegetation is the primary indicator, which must be present under normal circumstances. However, in practise the soil wetness indicator tends to be the most important, and the other three indicators are used in a confirmatory role. The reason is that vegetation responds relatively quickly to changes in soil moisture regime or management and may be transformed; whereas the morphological indicators in the soil are far more permanent and will hold the signs of frequent saturation long after a wetland has been drained (perhaps for several centuries).

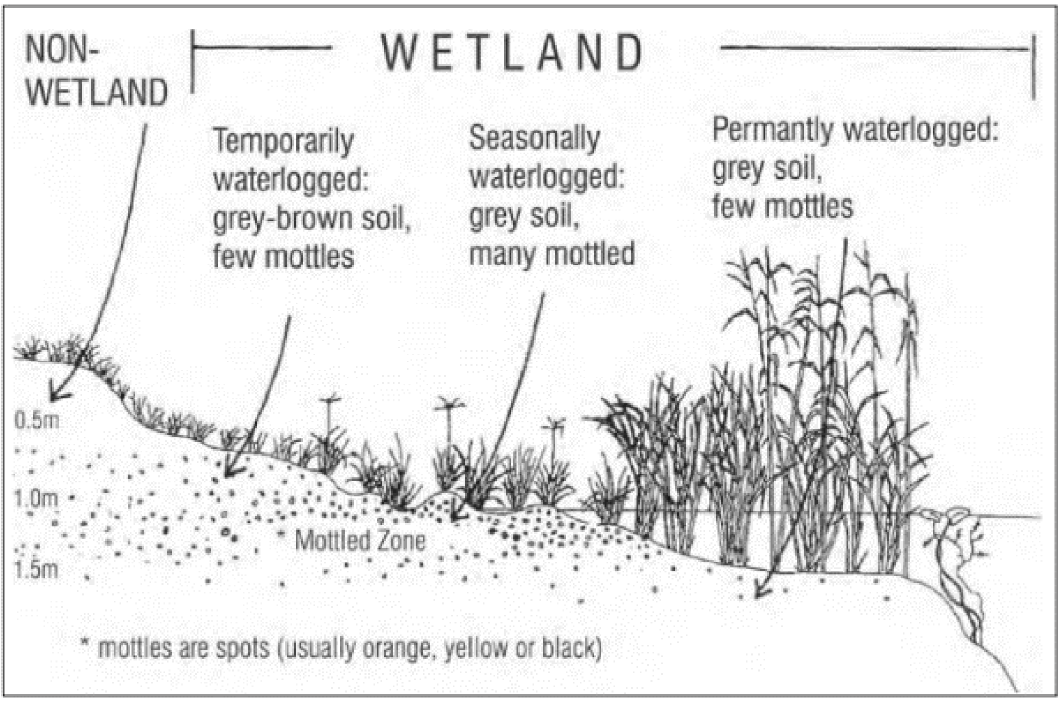

Figure A12.1: Cross section through a wetland, indicating how the soil wetness and vegetation indicators change as one moves along a gradient of decreasing wetness, from the middle to the edge of the wetland. Source: Donovan Kotze, University of KwaZulu-Natal.

The permanent, seasonal and temporary wetness zones can be characterised to some extent by the soil wetness indicators that they display (Table A12.1)

A12.1: Soil Wetness Indicators in the various wetland zones

TEMPORARY ZONE	SEASONAL ZONE	PERMANENT ZONE
Minimal grey matrix (<10%)	Grey matrix (<10%)	Prominent grey matrix
Few high chroma mottles	Many low chroma mottles present	Few to no high chroma mottles
Short periods of saturation (less than three months per annum)	Significant periods of wetness (at least three months per annum)	Wetness all year round (possible sulphuric odour)

Table A12.2: Relationship between wetness zones and vegetation types and classification of plants according to occurrence in wetlands

VEGETATION	TEMPORARY WETNESS ZONE	SEASONAL WETNESS ZONE	PERMANENT WETNESS ZONE
Herbaceous	Predominantly grass species; mixture of species which occur extensively in non-wetland areas, and hydrophilic plant species which are restricted largely to wetland areas	Hydrophilic sedges and grasses restricted to wetland areas	Dominated by: (1) emergent plants, including reeds (*Phragmites australis*), a mixture of sedges and bulrushes (Typha capensis), usually >1m tall; or (2) floating or submerged aquatic plants.
Woody	Mixture of woody species which occur extensively in non-wetland	Hydrophilic woody species	Hydrophilic woody species, which are restricted to wetland areas.

	areas, and hydrophilic plant species which are restricted largely to wetland areas.	restricted to wetland areas	Morphological adaptations to prolonged wetness (e.g. prop roots).

SYMBOL	HYDRIC STATUS	DESCRIPTION/OCCURRENCE
Ow	Obligate wetland species	Almost always grow in wetlands (>90% occurrence)
Fw/F+	Facultative wetland species	Usually grow in wetlands (67-99% occurrence) but occasionally found in non-wetland areas
F	Facultative species	Equally likely to grow in wetlands (34-66% occurrence) and non-wetland areas
Fd/F-	Facultative dryland species	Usually grow in non-wetland areas but sometimes grow in wetlands (1-34% occurrence)
D	Dryland species	Almost always grow in drylands

In order to identify the wetland types, using Kotze *et al.* (2009) and Ollis *et al*. (2013), a characterisation of hydrogeomorphic (HGM) types was conducted. These have been defined based on the geomorphic setting of the wetland in the landscape (e.g. hillslope or valley bottom, whether drainage is open or closed), water source (surface water dominated or sub-surface water dominated), how water flows through the wetland (diffusely or channelled) and how water exits the wetland (Figure A12.2).

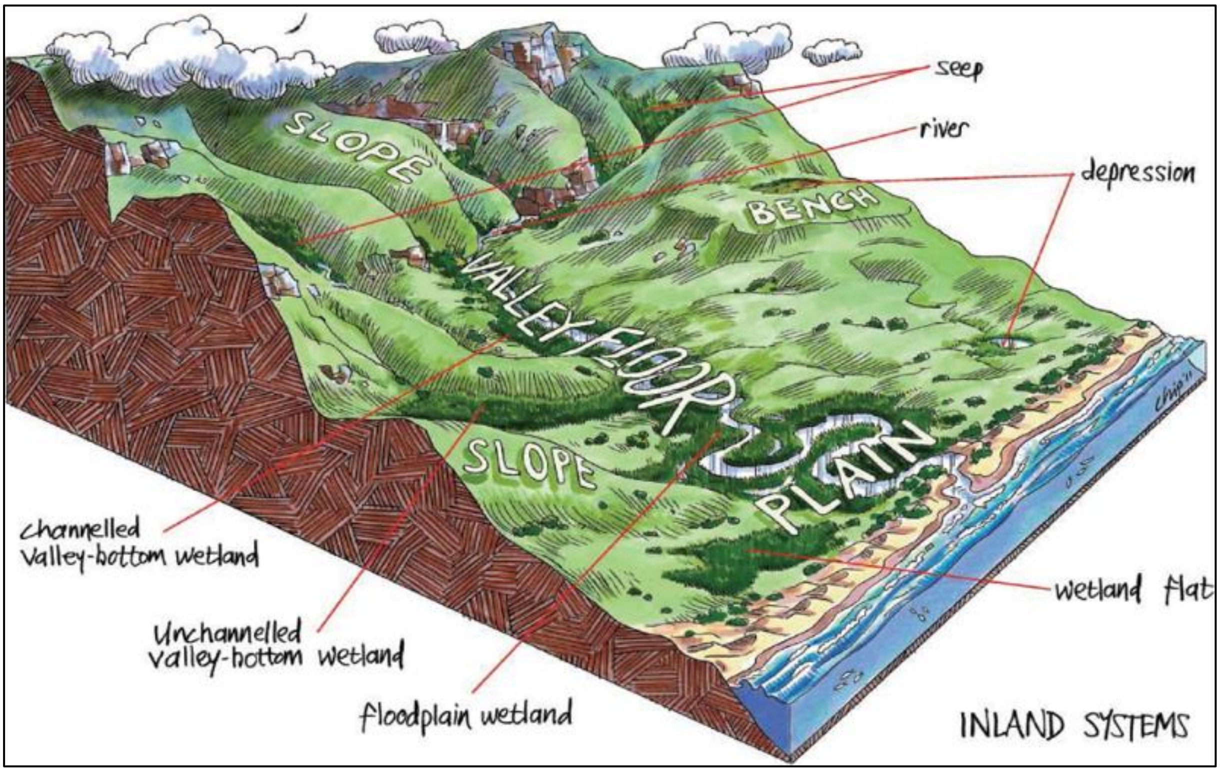

Figure A12.2: Illustration of wetland types and their typical landscape setting (From Ollis et al. 2013)

12.2 Delineation of Riparian Areas

Riparian zones are described as "the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils, and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent areas" i , Riparian zones can be thus be distinguished from adjacent terrestrial areas through their association with the physical structure (banks) of the river or stream, as well as the distinctive structural and compositional vegetation zones between the riparian and upland terrestrial areas (Figure 12.3). Unlike wetland areas, riparian zones are usually not saturated for a long enough duration for redoxymorphic features to develop. Riparian zones instead develop in response to (and are adapted to) the physical disturbances caused by frequent overbank flooding from the associated river or stream channel.

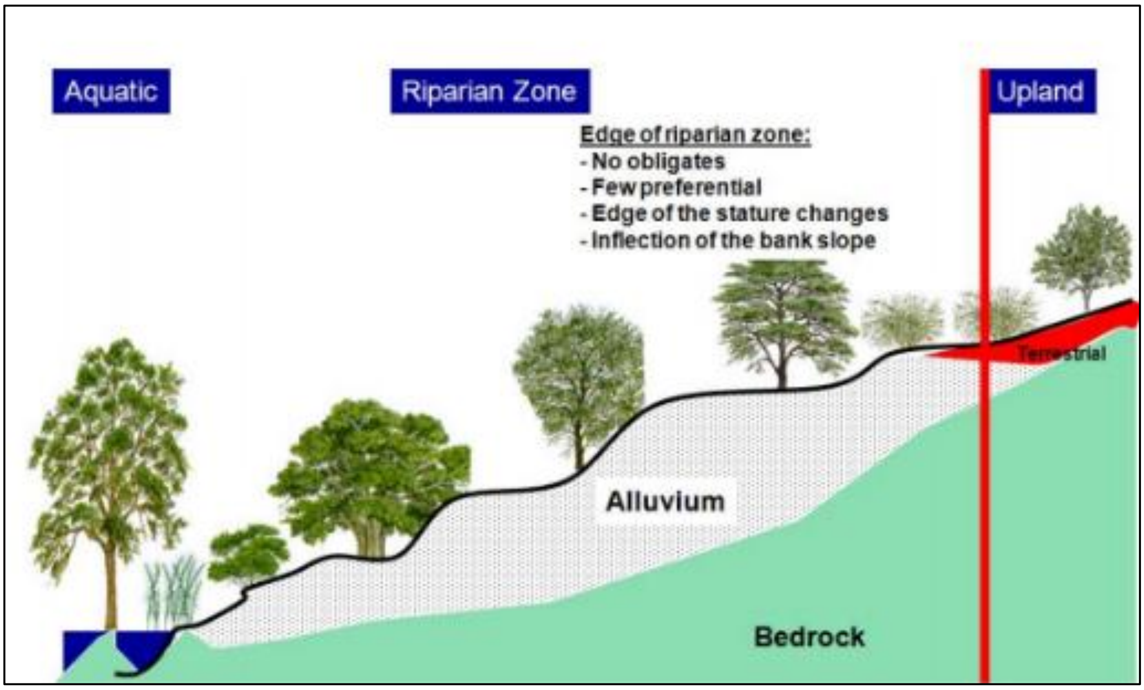

Figure A12.3: A schematic diagram illustrating the edge of the riparian zone on one bank of a large river. Note the coincidence of the inflection (in slope) on the bank with the change in vegetation structure and composition. The edge of the riparian zone coincides with an inflection point on the bank; where there are not obligates upslope; few preferential. The boundary also coincides with the outer edge of the stature differences (DWAF 2008).

Like wetlands, riparian areas can be identified using a set of indicators. The indicators for riparian areas are: - **Landscape position**; - Alluvial soils and recently deposited material; - **Topography** associated with riparian areas; and - **Vegetation** associated with riparian areas. Landscape Position As discussed above, a typical landscape can be divided into 5 main units), namely the: - Crest (hilltop); - Scarp (cliff); - Midslope (often a convex slope); - Footslope (often a concave slope); and - Valley bottom. Amongst these landscape units, riparian areas are only likely to develop on the valley bottom landscape units (i.e. adjacent to the river or stream channels; along the banks comprised of the sediment deposited by the channel). Alluvial soils are soils derived from material deposited by flowing water, especially in the valleys of large rivers. Riparian areas often, but not always, have alluvial soils. Whilst the presence of alluvial soils cannot always be used as a primary indicator to accurately delineate riparian areas, it can be used to confirm the topographical and vegetative indicators. Quaternary alluvial soil deposits are often indicated on geological maps, and whilst the extent of these quaternary alluvial deposits usually far exceeds the extent of the contemporary riparian zone; such indicators are useful in identifying areas of the landscape where wider riparian zones may be expected to occur.

Topography and recently deposited material associated with riparian areas The National Water Act definition of riparian zones refers to the structure of the banks and likely presence of alluvium. A good indicator of the presence of riparian zones is the presence of alluvial deposited material adjacent to the active channel (such as benches and terraces), as well as the wider incised “macro-channels” which are typical of many of southern Africa’s eastern seaboard rivers. Recently deposited alluvial material outside of the main active channel banks can indicate a currently active flooding area; and thus the likely presence of wetlands. Vegetation associated with riparian areas unlike the delineation of wetland areas, where redoxymorphic features in the soil are the primary indicator, the identification of riparian areas relies heavily on vegetative indicators. Using vegetation, the outer boundary of a riparian area can be defined as the point where a distinctive change occurs: - in species composition relative to the adjacent terrestrial area; and - in the physical structure, such as vigour or robustness of growth forms of species similar to that of adjacent terrestrial areas. Growth form refers to the health, compactness, crowding, size, structure and/or numbers of individual plants.

As with the delineation approach for wetlands, the field delineation method for riparian areas focuses on two main indicators of riparian zones: - **Vegetation Indicators**, and - **Topography** of the banks of the river or stream.

Additional verification can be obtained by examining for any recently alluvial deposited material to indicate the extent of flooding and thus obtain at least a minimum riparian zone width. The following procedure should be used for delineation of riparian zones: A good rough indicator of the outer edge of the riparian areas is the edge of the macro channel bank. This is defined as the outer bank of a compound channel, and should not be confused with the active river or stream channel bank. The macro-channel is an incised feature, created by uplift of the subcontinent which caused many rivers to cut down to the underlying geology and creating a sort of “restrictive floodplain” within which one or more active channels flow. Floods seldom have any known influence outside of this incised feature. Within the macro-channel, flood benches may exist between the active channel and the top of the macro channel bank. These depositional features are often covered by alluvial deposits and may have riparian vegetation on them. Going (vertically) up the macro channel bank often represents a dramatic decrease in the frequency, duration and depth of flooding experienced, leading to a corresponding change in vegetation structure and composition.

12.3 Present Ecological State (PES) – Wetlands

WET-Health assists in assessing the health of wetlands using indicators based on geomorphology, hydrology and vegetation. For the purposes of rehabilitation planning and assessment, WET-Health helps users understand the condition of the wetland in order to determine whether it is beyond repair, whether it requires rehabilitation intervention, or whether, despite damage, it is perhaps healthy enough not to require intervention. It also helps diagnose the cause of wetland degradation so that rehabilitation workers can design appropriate interventions that treat both the symptoms and causes of degradation.

WET-Health is tailored specifically for South African conditions and has wide application, including assessing the Present Ecological State of a wetland. There are two levels of complexity: Level 1 is used for assessment at a broad catchment level and Level 2 provides detail and confidence for individual wetlands based on field assessment of indicators of degradation (e.g. presence of alien plants). A basic tertiary education in agriculture and/or environmental sciences is required to use it effectively. Level 1 was utilised for the assessment of the wetlands impacted upon by the Dambuza Road upgrade.

WET-Health is a tool designed to assess the health or integrity of a wetland. Wetland health is defined as a measure of the deviation of wetland structure and function from the wetland’s natural reference condition. This technique attempts to assess hydrological, geomorphological and vegetation health in three separate modules:

- **Hydrology** is defined in this context as the distribution and movement of water through a wetland and its soils. This module focuses on changes in water inputs as a result of changes in catchment activities and characteristics that affect water supply and its timing, as well as on modifications within the wetland that alter the water distribution and retention patterns within the wetland.

- **Geomorphology** is defined in this context as the distribution and retention patterns of sediment within the wetland. This module focuses on evaluating current geomorphic health through the presence of indicators of excessive sediment inputs and/or losses for clastic (minerogenic) and organic sediment (peat).
- **Vegetation** is defined in this context as the vegetation structural and compositional state. This module evaluates changes in vegetation composition and structure as a consequence of current and historic onsite transformation and/or disturbance.

The overall approach is to quantify the impacts of human activity or clearly visible impacts on wetland health, and then to convert the impact scores to a Present State score. The tool attempts to standardise the way that impacts are calculated and presented across each of the modules. This takes the form of assessing the spatial extent of impact of individual activities and then separately assessing the intensity of impact of each activity in the affected area. The extent and intensity are then combined to determine an overall magnitude of impact (Table A12.3).

Impact scores obtained for each of the modules reflect the degree of change from natural reference conditions. Resultant health scores fall into one of six health categories (A-F) on a gradient from "unmodified/natural" (Category A) to "severe/complete deviation from natural" (Category F) as depicted in Table A12.4, below. This classification is consistent with DWAF categories used to evaluate the present ecological state of aquatic systems.

Table A12.3: Guideline for interpreting the magnitude of impacts on integrity (Macfarlane et al., 2008).

IMPACT CATEGORY	DESCRIPTION	SCORE
None	No discernible modification or the modification is such that it has no impact on this component of wetland integrity.	0 – 0.9
Small	Although identifiable, the impact of this modification on this component of wetland integrity is small.	1 – 1.9
Moderate	The impact of this modification on this component of wetland integrity is clearly identifiable, but limited.	2 – 3.9
Large	The modification has a clearly detrimental impact on this component of wetland integrity. Approximately 50% of wetland integrity has been lost.	4 – 5.9
Serious	The modification has a highly detrimental effect on this component of wetland integrity. Much of the wetland integrity has been lost but remaining integrity is still clearly identifiable.	6 – 7.9
Critical	The modification is so great that the ecosystem processes of this component of wetland integrity are almost totally destroyed, and 80% or more of the integrity has been lost.	8 – 10

Table A12.4. Health categories used by WET-Health for describing the integrity of wetlands (after Macfarlane et al., 2008).

IMPACT CATEGORY	DESCRIPTION	RANGE	PES CATEGORY
None	Unmodified, natural.	0 – 0.9	**A**
Small	Largely natural with few modifications. A slight change in ecosystem processes is discernible and a small loss of natural habitats and biota may have taken place.	1 – 1.9	**B**
Moderate	Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact	2 – 3.9	**C**
Large	Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4 – 5.9	**D**
Serious	The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still	6 – 7.9	**E**
Critical	Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8 – 10	**F**

An overall wetland health score was calculated by weighting the scores obtained for each module and combining them to give an overall combined score using the following formula:

Overall health rating = [(Hydrology*3) + (Geomorphology*2) + (Vegetation*2)] / 7

This overall score assists in providing an overall indication of wetland health/functionality which can in turn be used for recommending appropriate management measures.

12.4 Wetland Functional Importance (Goods and Services)

WET-EcoServices is used to assess the goods and services that individual wetlands provide, thereby aiding informed planning and decision making. It is designed for a class of wetlands known as palustrine wetlands (i.e. marshes, floodplains, vleis or seeps). The tool provides guidelines for scoring the importance of a wetland in delivering each of 20 different ecosystem services (including flood attenuation, sediment trapping and provision of livestock grazing). The first step is to characterise wetlands according to their hydro-geomorphic setting (e.g. floodplain). Ecosystem service delivery is then assessed either at Level 1, based on existing knowledge or at Level 2, based on a field assessment of key descriptors (e.g. flow pattern through the wetland).

The overall goal of WET-EcoServices is to assist decision makers, government officials, planners, consultants and educators in undertaking quick assessments of wetlands, specifically in order to reveal the ecosystem services that they supply. This allows for more informed planning and decision making. WET-EcoServices includes the assessment of several ecosystem services (listed in Table A12.5) - that is, the benefits provided to people by the ecosystem.

Ecosystem services supplied by wetlands	**Indirect benefits**	**Regulating and supporting benefits**	Flood attenuation		The spreading out and slowing down of floodwaters in the wetland, thereby reducing the severity of floods downstream
			Streamflow regulation		Sustaining streamflow during low flow periods
			Water quality enhancement benefits	Sediment trapping	The trapping and retention in the wetland of sediment carried by runoff waters
				Phosphate assimilation	Removal by the wetland of phosphates carried by runoff waters
				Nitrate assimilation	Removal by the wetland of nitrates carried by runoff waters
				Toxicant assimilation	Removal by the wetland of toxicants (e.g. metals, biocides and salts) carried by runoff waters
				Erosion control	Controlling of erosion at the wetland site, principally through the protection provided by vegetation.
			Carbon storage		The trapping of carbon by the wetland, principally as soil organic matter
	Direct benefits	**Biodiversity maintenance**[2]			Through the provision of habitat and maintenance of natural process by the wetland, a contribution is made to maintaining biodiversity
		Provisioning benefits	Provision of water for human use		The provision of water extracted directly from the wetland for domestic, agriculture or other purposes
			Provision of harvestable resources		The provision of natural resources from the wetland, including livestock grazing, craft plants, fish, etc.
			Provision of cultivated foods		The provision of areas in the wetland favourable for the cultivation of foods
		Cultural benefits	Cultural heritage		Places of special cultural significance in the wetland, e.g., for baptisms or gathering of culturally significant plants
			Tourism and recreation		Sites of value for tourism and recreation in the wetland, often associated with scenic beauty and abundant birdlife
			Education and research		Sites of value in the wetland for education or research

Table A12.5: Ecosystem services assessed by WET-Ecoservices

12.5 Ecological Importance & Sensitivity (EIS) - Wetlands

The Ecological Importance and Sensitivity was determined by utilising a rapid scoring system. The system has been developed to provide a scoring approach for assessing the Ecological, Hydrological Functions; and Direct Human Benefits of importance and sensitivity of wetlands. These scoring assessments for these three aspects of wetland importance and sensitivity have been based on the requirements of the NWA, the original Ecological Importance and Sensitivity assessments developed for riverine assessments (DWAF, 1999), and the work conducted by Kotze et al (2008) on the assessment of wetland ecological goods and services from the WET-EcoServices tool (Rountree, 2010). An example of the scoring sheet is attached as Table A12.6. The scores are then placed into a category of very low, low, moderate, high and very high as shown in Table 12.7.

Table A12.6: Example of scoring sheet for Ecological Importance and sensitivity

ECOLOGICAL IMPORTANCE AND SENSITIVITY:			
Ecological Importance	Score (0-4)	*Confidence (1-5)*	**Motivation for site**
Biodiversity support			
Presence of Red Data species			
Populations of unique species			
Migration/breeding/feeding sites			
Landscape scale			
Protection status of the wetland			
Protection status of the vegetation type			
Regional context of the ecological integrity			
Size and rarity of the wetland type/s present			
Diversity of habitat types			
Sensitivity of the wetland			
Sensitivity to changes in floods			
Sensitivity to changes in low flows/dry season			
Sensitivity to changes in water quality			
ECOLOGICAL IMPORTANCE & SENSITIVITY			
HYDROLOGICAL/FUNCTIONAL IMPORTANCE			
IMPORTANCE OF DIRECT HUMAN BENEFITS			
OVERALL IMPORTANCE			

Table A12.7: Category of score for the Ecological Importance and Sensitivity

RATING	EXPLANATION
None, Rating = 0	Rarely sensitive to changes in water quality/hydrological regime
Low, Rating =1	One or a few elements sensitive to changes in water quality/hydrological regime
Moderate, Rating =2	Some elements sensitive to changes in water quality/hydrological regime
High, Rating =3	Many elements sensitive to changes in water quality/ hydrological regime
Very high, Rating =4	Very many elements sensitive to changes in water quality/ hydrological regime

12.6 Direct, Indirect and Cumulative Impacts Methodology

Direct, indirect and cumulative impacts should be assessed in terms of the following criteria:

- The **nature**, which shall include a description of what causes the effect, what will be affected and how it will be affected.
- The **extent**, wherein it will be indicated whether the impact will be local (limited to the immediate area or site of development) or regional, and a value between 1 and 5 will be assigned as appropriate (with 1 being low and 5 being high).

- The **duration**, wherein it will be indicated whether:
    - The lifetime of the impact will be of a very short duration (0-1 years) – assigned a score of 1.
    - The lifetime of the impact will be of short duration (2-5 years) – assigned a score of 2;
    - Medium term (5-15 years) – assigned a score of 3;
    - Long-term (> 15 years) – assigned a score of 4; or
    - Permanent – assigned a score of 5.
- The **magnitude**, quantified on a scale of 0-10, where:
    - 0 is small and will have no effect on the environment,
    - 2 is minor and will not result in an impact on processes,
    - 4 is low and will cause a slight impact on processes,
    - 6 is moderate and will result in processes continuing but in a modified way,
    - 8 is high (processes are altered to the extent that they temporarily cease), and
    - 10 is very high and results in complete destruction of patterns and permanent cessation of processes.
- The **probability** of occurrence, which shall describe the likelihood of the impact actually occurring. Probability will be estimated on a scale of 1-5, where:
    - 1 is very improbable (probably will not happen),
    - 2 is improbable (some possibility, but low likelihood),
    - 3 is probable (distinct possibility),
    - 4 is highly likely (most likely) and;
    - 5 is definite (impact will occur regardless of any prevention measures).
- The **significance**, which shall be determined through a synthesis of the characteristics described above and can be assessed as low, medium or high;
    - The degree to which the impact can be reversed.
    - The degree to which the impact may cause irreplaceable loss of resources; and
    - The degree to which the impact can be mitigated.
- The significance is calculated by combining the criteria in the following formula, **S = (E+D+M) P**, where:
    - S = significance weighting
    - E = extent
    - D = duration
    - M = magnitude
    - P = probability

- The significance weightings for each potential impact are as follows:
    - <30 points: Low (i.e. where this impact would not have a direct influence on the decision to develop the area),
    - 30-60 points: Medium (i.e. where the impact could influence the decision to develop in the area unless it is effectively mitigated),
    - >60 points: High (i.e. where the impact must have an influence on the decision process to develop the area).

13 INDEMNITY AND COPYRIGHT

The project deliverables, including the reported results, comments, recommendations and conclusions, are based on the author’s professional knowledge as well as available information. The author reserves the right to modify aspects of the report including the recommendations if and when new information may become available from on-going research or further work in this field or pertaining to this investigation. The author has exercised reasonable skill, care and diligence in the provision of services, however, accepts no liability or consequential liability for the use of the supplied project deliverables and any information or material contained therein. The client, including their agents, by receiving these deliverables indemnifies Sharples Environmental Services cc (including its members, employees and sub-consultants) against any actions, claims, demands, losses, liabilities, costs, damages and expenses arising directly or indirectly from or in connection with services rendered, directly or indirectly by Sharples Environmental Services cc. All intellectual property rights and copyright associated with Sharples Environmental Services cc services are reserved and project deliverables may not be modified or incorporated into subsequent reports, in any form or by any means, without the written consent of the author. This also refers to electronic copies of this report. Similarly, this report should be appropriately referenced if the results, recommendations or conclusions stated in this report are used in subsequent documentation.

14 SPECIALIST CV

Debra Jane Fordham *(Author)*

Aquatic Ecologist working in George at Sharples Environmental Services cc as a specialist consultant and managing water use licensing applications (WULAs). Debbie holds a M.Sc. degree in Environmental Science from Rhodes University, by thesis, entitled: The geomorphic origin and evolution of the Tierkloof Wetland, a peatland dominated by *Prionium serratum* in the Western Cape.

Debbie has conducted many aquatic habitat assessments and rehabilitation plans of various spatial and temporal scales, in numerous locations within South Africa. These assessments include wetland, river, and estuary health assessments, rehabilitation plans, water quality analysis, monitoring recommendations, and generally compiling reports that clearly convey the findings and contribute to future management. She has also completed Water Use License Applications, Basic Assessment Reports and Environmental Management Plans. Debbie is highly proficient with GIS mapping software and incorporates spatial analysis in all assessments.

Key skills:

- Desktop mapping and infield assessment for wetland/ riparian habitat delineation
- Assessment of wetland and riparian functional importance (EIS) and Present Ecological State (PES) now including the WET-Health V2 tool, amongst others.
- Evaluating impacts to wetland and riparian systems from proposed developments
- Identifying mitigation measures and developing monitoring and rehabilitation plans
- WULA, EIA and BAR Applications
- ArcGIS V10, QGIS 2.18, CoralDraw X4, Strater V3, Statistica V9, MSOffice

Tertiary Education at Rhodes University, South Africa:

<u>M.Sc. Environmental Science</u>

Master of Science degree, by thesis, entitled:
The geomorphic origin, evolution and collapse of a peatland dominated by Prionium serratum: a case study of the Tierkloof Wetland, Western Cape.(Supervised by Prof. Fred Ellery)

<u>BA Honours – Environmental Science</u>

Honours Dissertation: The status and use of Aloe ferox. Mill in the Grahamstown commonage, South Africa. (Supervised by Prof. Sheona Shackleton)

<u>Honours Subjects</u>

- Wetland Ecology
- Environmental Water Quality /Toxicology
- Environmental Impact Assessment (EIA)
- Biodiversity, Non-Timber Forest Products (NTFPs) and Rural Livelihoods
- Statistics

<u>BA Degree – Environmental Science and Geography</u>

Current position: Aquatic Ecologist

Sharples Environmental Services cc: 2016/08/10 - Present

Debbie fulfils the specific requirements of each project with regards to the relevant aquatic legislation, such as conducting aquatic habitat impact reports and Water Use Licence Applications (WULAs). This mostly requires undertaking ground-truthing, classification, infield identification, delineation, impact assessment and mapping of aquatic ecosystems. SES conduct Present Ecological State (PES), functional importance assessments and Ecological Importance and Sensitivity (EIS) assessments of aquatic ecosystems. She conducts environmental impact and environmental sensitivity (constraints) assessments on aquatic habitats to determine if they are at risk of being impacted upon by proposed development areas during construction and operational phases of development. Including identifying direct, indirect, and cumulative impacts that proposed developments will have on aquatic habitats and the significance of these impacts and recommend actions that should be taken to prevent impacts on aquatic habitats. She also determines and maps No-Go and buffer zones utilising professional knowledge and buffer zone guidelines for rivers, wetlands and estuaries.

Publications and memberships:

Bekker, D. J. & Shackleton, S. 2010. The status and use of *Aloe ferox Mill*. in the Grahamstown commonage. Policy Brief, Rhodes University

- Professional Wetland Scientist applicant with SWS
- Southern Cape Wetland Society (SCWS)
- South African Wetlands Society (SAWS)
- Freshwater Ecosystem Network (FEN)
- Southern African Association of Geomorphologists (SAAG)
- DWAF accredited wetland delineation

Recent Aquatic Impact Assessment Projects:

- *Installation of A Water Pipeline from An Existing Borehole to The Herbertsdale Reservoir, Mossel Bay Municipality*
- *Unauthorised Clearance of Vegetation and Construction of a Dam on Farm Angeliersbosch Re/157, Prince Albert*
- *Rehabilitation of The Excavation of a Channel Within the Brandwag River, On the Remainder of Farm Bowerf 161, Brandwacht, Mossel Bay*
- *Rehabilitation Plan for activities On A Portion of Remainder Portion 104 Of the Farm Modder Rivier No 209, George*
- *Aquatic Impact Assessment for The Proposed Extension of Walvis Street, Mossel Bay*
- *Rehabilitation Plan for the transformation of agricultural land to commercial land on Farm Re 109/209, George*
- *Aquatic assessment for the proposed Dana Bay Access Road, near Mossel Bay*
- *Invasive Alien Plant Control Plan for New Horizons Mixed-Use Development on Farm Hillview No. 437, Plettenberg Bay*
- *Cemetery expansion on Erf 566 and 480, Melkhoutfontein*
- *The expansion of Goue Akker Cemetery in Beaufort West*

- *Construction of a bulk sewerage pipeline from Green Valley township, Wittedrift, to the Plettenberg Bay WWTW*
- *Periodic Maintenance of Trunk Road 31- Barrydale To Ladismith (Km 30.89 To Km 76.06), Western Cape Province*
- *Expansion of the Gansbaai Sand en Klip Quarry*
- *Seven Oaks Residential Development, Wittedrift, Plettenberg Bay*
- *Gran Sasso Quarry water abstraction and proposed construction of a road crossing a watercourse, Tygervalley, Cape Town*
- *Maintenance of Trunk Road 33/4 and Trunk Road 34/2, though Meiringspoort, Western Cape Province*
- *Proposed Waste Water Treatment Works, Irrigation Activities & Effluent Discharge by Parmalat SA (Pty) Ltd, Bonnievale*
- *Development of Remainder of Erf 562 Kurland, Plettenberg Bay*
- *Ladismith Cheese Water Use Application*
- *Construction of A 22kv Overhead Powerline, near Humansdorp, Eastern Cape*
- *Development of Herold's Bay Country Estate on A Portion of Portion 7 Of Farm Buffelsfontein No. 204, Herold's Bay*
- *Groot Witpan and Konga Pan salt mining, Northern Cape*
- *Gemsbok Horn salt pan mine prospecting*
- *Hartenbos Estuary Habitat Integrity Assessment with Fish Survey and water quality analysis*
- *The proposed Aalwyndal Precinct Plan Development: Biodiversity Component*
- *Tweekuilen Estuary Habitat Integrity Assessment with Fish Survey*
- *Residential Development on Portion 3 of Kraaibosch 195, George*

End