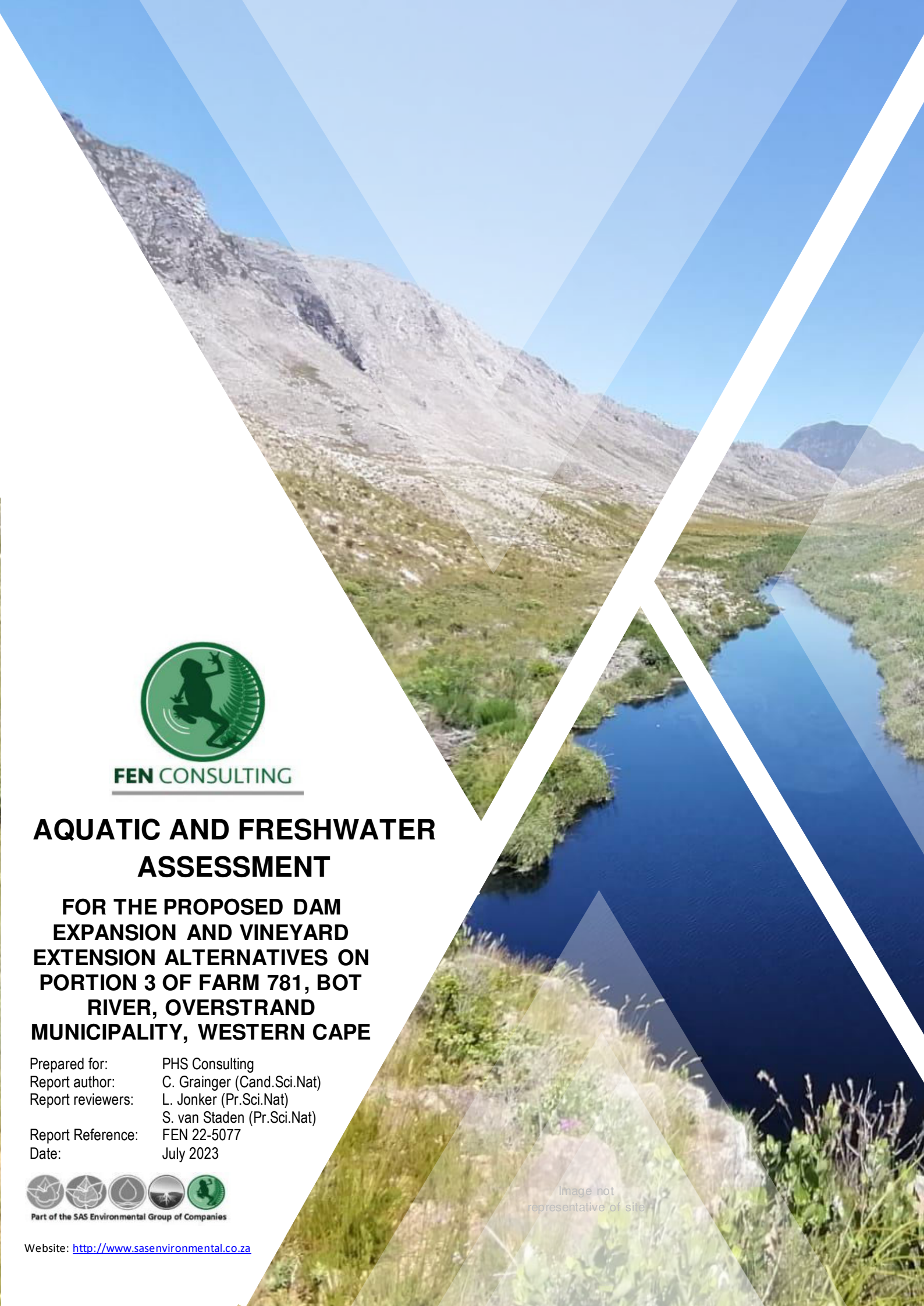


FEN CONSULTING

AQUATIC AND FRESHWATER ASSESSMENT

FOR THE PROPOSED DAM EXPANSION AND VINEYARD EXTENSION ALTERNATIVES ON PORTION 3 OF FARM 781, BOT RIVER, OVERSTRAND MUNICIPALITY, WESTERN CAPE

Prepared for:	PHS Consulting
Report author:	C. Grainger (Cand.Sci.Nat)
Report reviewers:	L. Jonker (Pr.Sci.Nat) S. van Staden (Pr.Sci.Nat)
Report Reference:	FEN 22-5077
Date:	July 2023

Part of the SAS Environmental Group of Companies

Website: http://www.sasenvironmental.co.za

EXECUTIVE SUMMARY

Freshwater Ecologist Network (FEN) Consulting (Pty) Ltd was appointed to conduct a specialist aquatic and freshwater assessment as part of the Environmental Authorisation (EA) and Water Use Authorisation (WUA) processes for the proposed Alternative 1 (hereafter,"Alternative') and Alternative 2, (hereafter, "Preferred") developments involving the expansion of dams and construction of a new dam to enable the irrigation, and thereby, extention of cultivation areas on portion 3 of farm 781, Bot River, Overstrand Municipality, Western Cape.

The Alternative development comprises the expansion of Erin de Vigne dam (hereafter, "Dam 1), installation of a pump station and the development of a cultivation area largely to the east, while the Preferred alternative comprises the development of a new dam directly below Dam 1, the expansion of Dam 2, and the development of cultivation areas between these dams and east of Dam 1, with no pump station proposed.

No freshwater ecosystems were found in the immediate vicinity of the Alternative and Preferred developments and thus do not pose any fatal flaws from a construction perspective. From an operational perspective, the overflow of Dam 2 would dissipate into a recently cleared terrestrial area and is also deemed acceptable. The overflow of Dam 1 could however elicit an impact on the Bot River which is approximately 220 m away and 35 m downgradient respectively, which warrants an aquatic assessment to determine the Bot River's ecological condition and the risk significance of development activities potentially impacting on this river. This report is thus largely an aquatic assesment with a small freshwater compliance component.

The field assessment took place in November during the Western Cape late Spring season when the Bot River was flowing and the results of the aquatic ecological assessments are summarised below as follows:

- Index of Habitat Integrity (IHI) – Instream Category D (Largely Modified)
- Index of Habitat Integrity (IHI) – Riparian Caregory E (Seriously Modified)
- Vegetation Response Index (VEGRAI) Category D/E (Largely to Seriously Modified)
- Macroinvertebrate Response Assessment Index (MIRAI) Category C (Moderately Modified)
- South African Scoring System (Version 5) (SASS5) Category B (Largely Natural)
- Invertebrate Habitat Assessment System (IHAS) 57 % (Fair)
- Ecological Importance and Sensitivity (EIS) High
- Specific Pollution Sensitivity Index (SPI) Moderate quality (Class C) and mesotrophic

Although no Target Ecological Category (TEC) from the Department of Water and Sanitation (DWS) Resource Water Quality Objectives (RWQO) is available for the Bot River, the above results are congruent with the majority of the upgradient catchment landuse being farmed, with water provisioning via in and off channel impoundments.

A comparison of diatom species between Dam 1 and the Bot River to infer the risk of dam spillage into the Bot River indicated no organic pollution in either, and that even though the dam was slightly more enriched compared to the Bot River (only due to stagnation and significantly less assimilation of nutrients by herbaceous vegetation), potential dam spillage is not envisaged to impact negatively on the Bot River, especially considering the good water quality of the dam.

Agricultural landuse has produced relatively bare cultivated areas that cause an increase in sediment laden runoff into freshwater ecosystems, as was evidenced in the study reach of the Bot River by the dense proliferation of *Phragmites australis* reeds. In and off channel impoundments decreased base flows and the timing, magnitude, frequency and duration of floods have largely altered the hydrological regime of the Bot River. There is also a significant establishment of alien vegetation within the catchment associated with riparian disturbances from agricultural pressure.

The application of the DWS GN509 Risk Assessment Matrix, as it relates to the National Water Act (Act 36 of 1998) (NWA), determined that all activities pertaining to the Alternative and Preferred development for the proposed Dam 1 expansion and downgradient cultivation area poses a low risk significance of impact to the Bot River. This is on condition that pertinent mitigation measures such as construction in the dry season, staff and vehicles remaining outside of the delineated extent of the Bot River, sediment traps and an Alien and Invasive Plant (AIP) management plan being in place, else the risk significances for activities may be increased to moderate. The preferred activities pertaining to the expansion of Dam 2 and the surrounding cultivation areas between Dam 1 and Dam 2 were not rated in the risk assessment matrix, as no quantum of impact to any freshwater ecosystems is envisaged.

In terms of the EA, the proposed Alternative and Preferred developments fall outside of the 32 m National Environmental Management Act (Act 107 of 1998) (NEMA) Zone of Regulation (ZoR) which warrants exception of the need to apply for EA with Department of Environmental Affairs and Development Planning (DEA&DP) in terms of Activity 12 and 19 of Listing Notice 1 of GN327 and Activity 14 of Listing Notice 3 of GN324. In terms of WUA, a portion of the proposed cultivation area under both the Alternative and Preferred development falls within the 100 m GN509 ZoR of the Bot River and the entirety of both the proposed Alternative and Preferred developments fall within the 500 m GN509 ZoR of an unchanneled valley bottom wetland ~ 170 m north east of the proposed development, all requiring WUA authorisation with the DWS.

Assuming that strict enforcement of cogent, well-developed mitigation measures takes place, the significance of impacts arising from the proposed development activities will be adequately managed and the overall PES of the Bot River will not be significantly impacted on. It is therefore the opinion of the freshwater specialist that the proposed development activities be considered favourably provided that all mitigation measures in this report are implemented.

MANAGEMENT SUMMARY

FEN Consulting (Pty) Ltd was appointed to conduct a specialist aquatic and freshwater assessment as part of the EA and WUA processes for the proposed Alternative and Preferred developments involving the expansion of dam/s to enable the irrigation, and thereby, extension of cultivation areas on portion 3 of farm 781, Bot River, Overstrand Municipality, Western Cape.

The Alternative development comprises the expansion of Erin de Vigne dam (hereafter, "Dam 1) from 6000 m^3 to 35 000 m^3 and the development of a ~ 7 ha cultivation area largely to the east of the dam, while the Preferred development comprises the development of a new 2000 m^3 dam directly below Dam 1, the expansion of Dam 2 from 25 000 m^3 to 67 000 m^3 and the development of cultivation areas between these dams and east of Dam 1, altogether comprising ~ 10 ha.

These are both off-channel dams that are gravity fed from the diversion weir offtake on the Huiskloof River ~ 2.7 km west and are located within highly disturbed areas. Dam 1 was recently deforested (sometime after April 2021) and Dam 2 consists of dense (mostly impenetrable) stands of alien invasive trees such as (*Pinus pinaster)* Pine, (*Acacia saligna*) Port Jackson and (Eucalyptus spp.) Bluegum. Very little natural vegetation remains among these trees which makes these areas ideal for cultivation (vineyards).

The purpose of this report is to define the aquatic and freshwater ecology of the study area by mapping freshwater ecosystems and describing their characteristics in terms of their Present Ecological State (PES), Ecological Importance and Sensitivity (EIS). This report aims to provide detailed information to guide the management of the proposed development activities, specifically those which have a bearing on the receiving freshwater environment, to ensure ongoing functioning of the ecosystem in support of local and regional conservation requirements and the provision of ecological services in the local area.

The field assessment took place in November during the Western Cape late Spring season when the Bot River was flowing (which was the only freshwater ecosystem envisaged to potentially be impacted on) and the results of the aquatic ecological assessments are summarised below in Table A.

Table A: Aquatic ecological assessment results of the Bot River (Alternative 1 illustrated here).

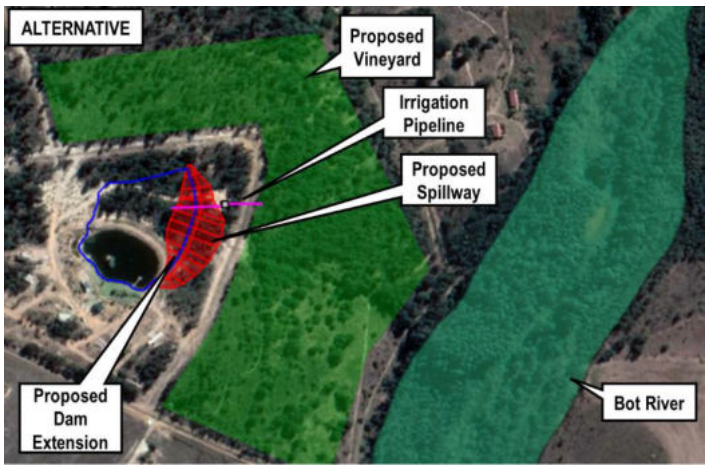
<table>
<tr><td colspan="3">Water Management Area:</td><td>Breede</td><td>Quaternary Catchment</td><td>G40G</td></tr>
<tr><td colspan="3">Ecoregion:</td><td>Southern Folded Mountains</td><td>Weather Conditions:</td><td>Warm and clear skies</td></tr>
<tr><td colspan="3">Flows and water clarity</td><td colspan="3">River was a very slow opaque run of barely perceptible flow</td></tr>
<tr><td colspan="3">Water Quality</td><td colspan="3" rowspan="8"> 

Figure A: Map of the proposed Alternative development and the Bot River.</td></tr>
<tr><td>Parameter</td><td>Dam</td><td>Bot River</td></tr>
<tr><td>pH</td><td>6.49</td><td>6.97</td></tr>
<tr><td>EC (mS/m)</td><td>34.5</td><td>126.0</td></tr>
<tr><td>Salinity (ppm)</td><td>158</td><td>630</td></tr>
<tr><td>TDS (mg/l)</td><td>240</td><td>892</td></tr>
<tr><td>DO (mg/l)</td><td>5.79</td><td>3.80</td></tr>
<tr><td>DO (%) saturation</td><td>77.0</td><td>55.5</td></tr>
<tr><td colspan="6">ECOLOGICAL ASSESSMENT OUTCOMEs</td></tr>
<tr><td colspan="3">Index of Habitat Integrity (IHI)</td><td colspan="3">Riparian Vegetation Assessment Index (VEGRAI)</td></tr>
<tr><td colspan="3">Instream IHI: 50.1 (Category D: Largely Modified)
Riparian IHI: 35.1 (Category E: Seriously Modified)</td><td colspan="3">VEGRAI score: 40.0 (Category D/E: Seriously Modified)</td></tr>
<tr><td colspan="3">South African Scoring System - Version 5 (SASS5)</td><td colspan="3">Invertebrate Habitat Assessment System (IHAS)</td></tr>
<tr><td colspan="3">Number of Families: 20</td><td colspan="2">Total IHAS Score</td><td>57% (Fair)</td></tr>
<tr><td colspan="3">Total Sass Score: 100</td><td colspan="3">Macro-Invertebrate Response Assessment Index (MIRAI)</td></tr>
<tr><td colspan="3">Average Score per Taxon: 5.0</td><td colspan="3">Category C (Moderately Modified)</td></tr>
<tr><td colspan="3">Ecological Condition: Category B (Largely Natural)</td><td colspan="3">Ecological Importance and Sensitivity (EIA)</td></tr>
<tr><td colspan="3">Specific Pollution Sensitivity Index</td><td>Biotic: High</td><td>Habitat: Very High</td><td>Overall: High</td></tr>
<tr><td colspan="3">Specific Pollution Sensitivity Index</td><td colspan="3">Moderate quality (Class C) and mesotrophic</td></tr>
</table>

Figure B: Photographs of the study area illustrating A) the existing Dam 1 for which expansion is proposed, B) the proposed Dam 1 expansion area C) the proposed vineyard area south of the proposed Dam 1 expansion, D) the reach of the Bot River downgradient of the proposed development E) and the existing Dam 2 surroundings.

The application of the DWS GN509 Risk Assessment Matrix, as it relates to the National Water Act (Act 36 of 1998) (NWA), determined that all activities pertaining to the Alternative and Preferred development for the proposed Dam 1 expansion and downgradient cultivation area poses a low risk significance of impact to the Bot River. This is on condition that pertinent mitigation measures such as construction in the dry season, staff and vehicles remaining outside of the delineated extent of the Bot River, sediment traps and an Alien and Invasive Plant (AIP) management plan being in place, else the risk significances for activities may be increased to moderate. **The Preferred activities pertaining to the expansion of Dam 2 and the surrounding cultivation areas between Dam 1 and Dam 2 were not rated in the risk assessment matrix as no quantum of impact to any freshwater ecosystems is envisaged.**

Only the activities pertaining to the expansion of Dam 1, or the newly proposed dam directly downgradient of Dam 1 and the cultivation areas east of Dam 1 were assessed.

Table B: Summary results of the DWS Risk Assessment applied to the Bot River for the significance of the Alternative and Preferred dam activities and Alternative and Preferred cultivation area activities downstream (east) of Dam 1.

	Impact and Aspect	Risk Rating	Reversibility of Impact
CONSTRUCTION PHASE	**Vehicular movement (transportation of construction materials and access to site)**	L	Fully Reversible
	➢ Transportation of construction materials can result in disturbances to soil, and increased risk of sedimentation to downstream Bot River; and ➢ Soil and stormwater contamination from oils and hydrocarbons originating from construction vehicles that may be flushed into the Bot River.		
	Removal of vegetation and disturbance to soil associated with the proposed dam expansion areas and proposed vineyard		
	➢ Sediment transported as runoff into the downgradient Bot River; ➢ Exposure of soil, leading to increased runoff, and erosion, and thus increased sedimentation of the Bot River; and ➢ Proliferation of alien vegetation as a result of disturbances.		
	Construction activities related to the expansion of the dams and proposed vineyard		
	➢ Runoff from stockpiled material or sediment laden runoff from the dam construction footprint and cleared vineyard areas could enter the downstream Bot River and increase its sediment load.		
	Rehabilitation of the proposed dams and vineyard areas		
	➢ AIP proliferation; ➢ New erosion and incision due to the expanded dam walls; and ➢ Litter and waste removal.		
	Impact and Aspect	**Risk Rating**	**Reversibility of Impact**
OPERATIONAL PHASE	**Overflow of dam 1 once full capacity has been reached** ➢ Terrestrial vegetation encroachment downstream of the dam; and ➢ Potential overtopping of the dam and the flushing of sediment laden runoff into the downgradient Bot River.	L	Partially reversible
	Future maintenance of the dams ➢ Soil compaction and disturbance around the dam; ➢ Staff operation of the vineyards; ➢ Potential sedimentation of downstream Bot River; and ➢ Vegetation degradation and alien invasive proliferation.		Fully reversible

In terms of the EA, the proposed Alternative and Preferred developments fall outside of the 32 m NEMA ZoR which warrants exception of the need to apply for EA with DEA&DP in terms of Activity 12 and 19 of Listing Notice 1 of GN327 and Activity 14 of Listing Notice 3 of GN324. In terms of WUA, a portion of the proposed cultivation area under both the Alternative and Preferred development falls within the 100 m GN509 ZoR of the Bot River and the entirety of both the proposed Alternative and Preferred developments falls within the 500 m GN509 ZoR of an unchanneled valley bottom wetland, all requiring WUA authorisation with the DWS.

Assuming that strict enforcement of cogent, well-developed mitigation measures takes place, the significance of impacts arising from the proposed development activities will be adequately managed and the overall PES of the Bot River will not be significantly impacted on.

It is therefore the opinion of the freshwater specialist that the proposed development activities be considered favourably provided that all mitigation measures in this report are implemented.

DOCUMENT GUIDE

The table below lists the specialist report requirements based on the NEMA Environmental Screening Tool for the assessment and reporting of impacts on aquatic biodiversity with very high sensitivity, in terms of Government Notice 320 as promulgated in Government Gazette 43110 of 20 March 2020 in line with the Department of Environmental Affairs screening tool requirements, as it relates to the National Environmental Management Act, 1998 (Act No. 107 of 1998).

No.	Requirements	Section in report
2.1	Assessment must be undertaken by a suitably qualified SACNASP registered specialist.	Appendix G
2.2	Description of the preferred development site, including the following aspects-	Section 4 and 5
2.2.1	a. Aquatic ecosystem type; b. Presence of aquatic species and composition of aquatic species communities, their habitat, distribution and movement patterns.	Section 4
2.2.2	Threat status, according to the national web based environmental screening tool of the species and ecosystems, including listed ecosystems as well as locally important habitat types identified.	Section 4
2.2.3	National and Provincial priority status of the aquatic ecosystem (i.e. is this a wetland or river Freshwater Ecosystem Priority Area (FEPA), a FEPA sub- catchment, a Strategic Water Source Area (SWSA), a priority estuary, whether or not they are free-flowing rivers, wetland clusters, etc., a CBA or an ESA; including for all a description of the criteria for their given status.	Section 4
2.2.4	A description of the Ecological Importance and Sensitivity of the aquatic ecosystem including: a. The description (spatially, if possible) of the ecosystem processes that operate in relation to the aquatic ecosystems on and immediately adjacent to the site (e.g. movement of surface and subsurface water, recharge, discharge, sediment transport, etc.); b. The historic ecological condition (reference) as well as Present Ecological State (PES) of rivers (in-stream, riparian and floodplain habitat), wetlands and/or estuaries in terms of possible changes to the channel, flow regime (surface and groundwater).	None. Entire site considered high aquatic sensitivity.
2.3	Identify any alternative development footprints within the preferred development site which would be of a "low" sensitivity as identified by the national web based environmental screening tool and verified through the Initial Site Sensitivity Verification.	None. Entire site considered high aquatic sensitivity.
2.4	Assessment of impacts - a detailed assessment of the potential impact(s) of the proposed development on the following very high sensitivity areas/ features:	Section 7
2.4.1	Is the development consistent with maintaining the priority aquatic ecosystem in its current state and according to the stated goal?	Yes, with implementation of the mitigation measures proposed in Section 7
2.4.2	Is the development consistent with maintaining the Resource Quality Objectives for the aquatic ecosystems present?	
2.4.3	How will the development impact on fixed and dynamic ecological processes that operate within or across the site, including: a. Impacts on hydrological functioning at a landscape level and across the site which can arise from changes to flood regimes (e.g. suppression of floods, loss of flood attenuation capacity, unseasonal flooding or destruction of floodplain processes); b. Change in the sediment regime (e.g. sand movement, meandering river mouth/estuary, changing flooding or sedimentation patterns) of the aquatic ecosystem and its sub-catchment; c. The extent of the modification in relation to the overall aquatic ecosystem (i.e. at the source, upstream or downstream portion, in the temporary / seasonal / permanent zone of a wetland, in the riparian zone or within the channel of a freshwater ecosystem, etc.). d. Assessment of the risks associated with water use/s and related activities.	Section 7
2.4.4	How will the development impact on the functionality of the aquatic feature including: a. Base flows (e.g. too little/too much water in terms of characteristics and requirements of system);	Section 7.

	b. Quantity of water including change in the hydrological regime or hydroperiod of the aquatic ecosystem (e.g. seasonal to temporary or permanent; impact of over abstraction or instream or off-stream impoundment of a wetland or river); c. Change in the hydrogeomorphic typing of the aquatic ecosystem (e.g. change from an unchanneled valley-bottom wetland to a channelled valley-bottom wetland); d. Quality of water (e.g. due to increased sediment load, contamination by chemical and/or organic effluent, and/or eutrophication); e. Fragmentation (e.g. road or pipeline crossing a wetland) and loss of ecological connectivity (lateral and longitudinal); and f. Loss or degradation of all or part of any unique or important features associated with or within the aquatic ecosystem (e.g. waterfalls, springs, oxbow lakes, meandering or braided channels, peat soil, etc).	
2.4.5	How will the development impact on key ecosystem regulating and supporting services especially Flood attenuation; Streamflow regulation; Sediment trapping; Phosphate assimilation; Nitrate assimilation; Toxicant assimilation; Erosion control; and Carbon storage.	Section 7
2.4.6	How will the development impact community composition (numbers and density of species) and integrity (condition, viability, predator-prey ratios, dispersal rates, etc.) of the faunal and vegetation communities inhabiting the site?	Section 7
2.4.7	In addition to the above, where applicable, impacts to the frequency of estuary mouth closure should be considered, in relation to: size of the estuary; availability of sediment; wave action in the mouth; protection of the mouth; beach slope; volume of mean annual runoff; and extent of saline intrusion (especially relevant to permanently open systems).	Section 7
3.	**The report must contain as a minimum the following information:**	
3.1	Contact details and curriculum vitae of the specialist including SACNASP registration number and field of expertise and their curriculum vitae;	Appendix G
3.2	A signed statement of independence by the specialist;	Appendix G
3.3	The duration, date and season of the site inspection and the relevance of the season to the outcome of the assessment;	Section 1
3.4	The methodology used to undertake the impact assessment and site inspection, including equipment and modelling used, where relevant;	Section 3, Appendix C and Appendix D
3.5	A description of the assumptions made and any uncertainties or gaps in knowledge or data as well as a statement of the timing and intensity of site inspection observations;	Section 1.3
3.6	Areas not suitable for development, to be avoided during construction and operation (where relevant);	Section 7
3.7	Additional environmental impacts expected from the proposed development based on those already evident on the site and a discussion on the cumulative impacts;	Section 7
3.8	A suitable construction and operational buffer for the aquatic ecosystem, using the accepted protocol;	Section 6
3.9	Impact management actions and impact management outcomes proposed by the specialist for inclusion in the EMPr;	Section 7
3.10	A motivation where the development footprint identified as per 2.3 were not considered stating reasons why these were not being considered; and	Section 7
3.11	A reasoned opinion, based on the finding of the specialist assessment, regarding the acceptability or not, of the development and if the development should receive approval, and any conditions to which the statement is subjected.	Section 7
3.12	A suitable construction and operational buffer for the aquatic ecosystem, using the accepted methodologies.	Section 6
3.13	Proposed impact management actions and impact management outcomes for inclusion in the Environmental Management Programme (EMPr).	Section 7
3.14	A motivation must be provided if there were development footprints identified as per paragraph 2.3 for reporting in terms of Section 24(5)(a) and (h) of the National Environmental Management Act, 1998 (Act No. 107 of 1998) that were identified as having a "low" aquatic biodiversity and sensitivity and that were not considered appropriate.	None. The entire study area falls within a high aquatic biodiversity sensitivity.
3.15	A substantiated statement, based on the findings of the specialist assessment, regarding the acceptability or not of the proposed development and if the proposed development should receive approval or not.	Section 8
3.16	Any conditions to which this statement is subjected.	Section 8

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

GLOSSARY OF TERMS

Abbreviations and Acronyms	Full Form	Definition (Where Applicable)
ASPT	Average Score Per Taxon	The average sensitivity of the aquatic community obtained by determining the sum of the sensitivity scores for each aquatic macro-invertebrate family observed and then dividing by the number of families present.
DEMC	Default Ecological Management Class	
DO	Dissolved Oxygen	Dissolved Oxygen is the amount of oxygen that is present in the water. It is measured in milligrams per litre (mg/L).
% DO sat	Dissolved Oxygen Saturation	In aquatic environments, oxygen saturation is a ratio of the concentration of dissolved oxygen in the water to the maximum amount of oxygen that will dissolve in the water at that temperature and pressure under stable equilibrium.
DWA	Department of Water Affairs	
DWAF	Department of Water Affairs and Forestry	
DWS	Department of Water and Sanitation (formerly known as DWA, DWAF, see above)	
EC	Electrical Conductivity	Electrical conductivity (EC) is a measure of the ability of water to conduct an electrical current. This ability is a result of the presence in water of ions such as carbonate, bicarbonate, chloride, sulphate, nitrate, sodium, potassium, calcium and magnesium, all of which carry an electrical charge.
EIS	Ecological Importance and Sensitivity	Ecological importance refers to the diversity, rarity or uniqueness of the habitats and biota. Ecological sensitivity refers to the ability of the ecosystem to tolerate disturbances and to recover from certain impacts.
EWR	Ecological Water Requirements	The flow patterns (magnitude, timing and duration) and water quality needed to maintain a riverine ecosystem in a particular condition. This term is used to refer to both the quantity and quality components.
FRAI	Fish Response Assessment Index	The FRAI is an assessment index based on the environmental intolerances and preferences of the reference fish assemblage and the response of the constituent species of the assemblage to particular groups of environmental determinants or drivers.
GDI	General Diatom Index	A diatom index based on genus level which is a measure of organic pollution.
IHAS	Integrated Habitat Assessment System	An assessment index to determine the suitability of the habitat at any assessment point for colonisation by aquatic macro-invertebrates.
IHI	Index of Habitat Integrity	The habitat integrity of a river refers to the maintenance of a balanced composition of physico-chemical and habitat characteristics on a temporal and spatial scale that are comparable to the characteristics of natural habitats of the region.
MIRAI	Macro-invertebrate Response Assessment Index	MIRAI integrates the ecological requirements of the invertebrate taxa in a community or assemblage to their response to modified habitat conditions.
NA	Not Applicable	
NEMA	National Environmental Management Act	
NEMBA	National Environmental Biodiversity Act	
NWA	National Water Act	
%PTV	Percentage Pollution Tolerant Valves	Indicates the diatoms in the sampled community that are tolerant to pollution, thus indicating the degree of eutrophication vs organic pollution. The %PTV score indicates whether nutrients or organic pollution contributed to the Trophic Diatom Index final score.

Abbreviations and Acronyms	Full Form	Definition (Where Applicable)
PES	Present Ecological State	The current state or condition of a water resource in terms of its biophysical components (drivers) such as hydrology, geomorphology and water quality and biological responses viz. fish, invertebrates, riparian vegetation). The degree to which ecological conditions of an area have been modified from natural (reference) conditions.
PEMC	Present Ecological Management Class	
Ref	Reference	
RQIS	Resource Quality Information Services	RQIS provides national water resource managers with aquatic resource data, technical information, guidelines and procedures that support the strategic and operational requirements for assessment and protection of water resource quality.
SA RHP	South African River Health Programme	The RHP serves as a source of information regarding the overall ecological status of river ecosystems in South Africa. For this reason, the RHP primarily makes use of in-stream and riparian biological communities (e.g. fish, invertebrates, vegetation) to characterise the response of the aquatic environment to multiple disturbances.
SASS5	South African Scoring System	An index to determine the integrity of the aquatic macro-invertebrate community at any given assessment point.
SPI	Specific Pollution Sensitivity Index	A diatom index utilising >1400 species to calculate its final score and provides a measure of organic pollution.
SQR	Sub-quaternary Reach	A finer subdivision of the quaternary catchments (the catchment areas of tributaries of main stem rivers in quaternary catchments).
TDI	Trophic Diatom Index	A diatom index which is a measure of the degree of organic and inorganic pollution.
RWQO	Resource Water Quality Objectives	*Guidelines set by the South African Department of Water and Sanitation (DWS), formerly DWA or DWAF, for various physico-chemical and biological parameters for various uses as well as ecosystem functioning.
VEGRAI	Riparian Vegetation Response Assessment Index	VEGRAI is designed for qualitative assessment of the response of riparian vegetation to impacts in such a way that qualitative ratings translate into quantitative and defensible results presented as Ecostatus Categories.
WMS	Water Management System	WMS is a suite of computer programmes developed for the Department of Water and Sanitation to provide information for water resource monitoring and management in South Africa.
WULA	Water Use License Application	The National Water Act (Act 36 of 1998) gives the Department of Water and Sanitation the tools to gather the information that we need for the optimal management of our water resources. The registration of water use is one of these tools.

The following guidelines were considered:

South African water quality guidelines volume 7, Aquatic ecosystems (DWAF, 1996): This reference provides percentage change guidelines as follows:

- **Electrical conductivity (EC)/Total Dissolved Solids (TDS)** concentrations should not be changed by > 15 % from the normal cycles of the water body under unimpacted conditions at any time of the year, and the amplitude and frequency of natural cycles in EC/TDS concentrations should not be changed;
- **pH values** should not be allowed to vary from the range of the background pH values for a specific site and time of day, by > 0.5 of a pH unit, or by > 5 %, and should be assessed by whichever estimate is the more conservative.
- **Dissolved Oxygen (DO)** concentration should be 80% to 120% of saturation. In addition, for the purposes of this report, any spatial or temporal change exceeding 15% was considered significant.

Note that EC and pH comparisons refer to temporal comparisons and because no guidelines were available for spatial comparisons, the temporal comparison guidelines were adopted and applied to spatial comparisons.

1 INTRODUCTION

1.1 Background

FEN Consulting (Pty) Ltd was appointed to conduct a specialist aquatic and freshwater assessment as part of the EA and WUA processes for the proposed Alternative and Preferred developments involving the expansion of dam/s to enable the extension and irrigation of cultivation areas on portion 3 of farm 781, Bot River, Overstrand Municipality, Western Cape.

In order to identify all watercourses that may potentially be impacted by the proposed development, a 500 m "zone of investigation" around the proposed expansion of the dam and vineyard, in accordance with Government Notice (GN) 509 of 2016 as published in the Government Gazette 40229 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998) (NWA), was used as a guide in which to assess possible sensitivities of the receiving environment. This area – i.e. the 500 m zone of investigation around the proposed development - will henceforth be referred to as the "investigation area".

The purpose of this report is to define the ecology of the study area by mapping freshwater ecosystems and describing their characteristics in terms of their Present Ecological State (PES), Ecological Importance and Sensitivity (EIS) This report aims to provide detailed information to guide the management of the proposed development activities, specifically those which have a bearing on the receiving freshwater environment, to ensure ongoing functioning of the ecosystem in support of local and regional conservation requirements and the provision of ecological services in the local area.

1.2 Structure of this report

This report investigates the impact significance of the proposed development, as explained in Section 2 below, in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) as well as the National Water Act, 1998 (Act No. 36 of 1998) by means of the Risk Assessment Matrix, as promulgated in GN 509 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998). The following structure is applicable to this report:

Section 1: Introduction
Provides an Introduction, the structure of this report and the assumptions and limitations.

Section 2: Project Description
Provides the location of the development as well as a summary of the related activities.

Section 3: Assessment Approach
Provides the relevant methodology and definitions applicable to this report, a description of the sensitivity mapping and the risk assessment approach.

Section 4: Desktop Assessment Results
Reports on the findings from the relevant national, provincial and municipal datasets (such as the National Freshwater Ecosystem Priority Areas [NFEPA], 2011 database; the 2014 DWS Resource Quality Information System (RQIS) Present Ecological State (PES)/ Ecological Importance and Sensitivity (EIS) database, the 2017 Western Cape Biodiversity Spatial Plan dataset and the 2018 National Biodiversity Assessment database were undertaken to aid in defining the PES and EIS of the watercourses.

Section 5: Site Based Aquatic Ecological Assessment Results
This section reports the following:

- A description and delineation of the freshwater ecosystems associated with the proposed development according to "Department of Water Affairs and Forestry (DWAF)[1] (2008): A practical Guideline Procedure for the Identification and Delineation of Wetlands and Riparian Zones";
- Delineation of all freshwater ecosystems (on a desktop basis) within 500 m of the proposed development in accordance with GN 509 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998);
- A description of the water quality, benthic algal, and macro-invertebrate community integrity expected to occur on site, including *in situ* measurements and rapid assessments;
- The EIS of the freshwater ecosystems according to the method described by DWAF, (1999); and
- The Present Ecological State (PES) of the freshwater ecosystems according to the resource directed measures guideline as advocated by Kleynhans and Louw (2008).

Section 6: Legislative Requirements
Provides the applicable legislative requirements based on the findings from Section 5 and indicates any applicable zones of regulation that may trigger various authorisation requirements.

Section 7: Impact and Risk Assessment
Provides the outcomes of the DWS Risk Assessment Matrix results which highlights all potential impacts and that may affect the watercourse. Management and mitigation measures are provided and an assessment on the reversibility of the impact which should be implemented during the construction and operational phases of the proposed development activities to assist in minimising the impact on the receiving environment.

Section 8: Conclusion
Summarises the key findings and recommendations based on the risk assessment outcomes.

1.3 Assumptions and Limitations

The following points serve to indicate the assumptions and limitations with regard to the aquatic ecological assessment:

- **Reference conditions are unknown:** The composition of aquatic biota in the study area, prior to major disturbance is unknown. For this reason, reference conditions are hypothetical, and are based on professional judgement and/or inferred from limited data available such as the Department of Water and Sanitation (DWS) Resource Quality Information Services (RQIS) PES/EIS database as discussed in Section 4.2.1.
- **Temporal variability:** The data presented in this report is based on a single site visit in November 2022. The effects of natural seasonal and long-term variation in the ecological conditions and aquatic biota found in the system is, therefore, unknown. Ideally aquatic assessments should be undertaken, as a minimum in the winter/high flow and summer/low flow seasons to account for and define seasonal variability.
- **Ecological assessment timing:** Aquatic and terrestrial ecosystems are dynamic and complex. It is possible that aspects, some of which may be important, could have been overlooked. A more reliable assessment of the biota would require seasonal sampling, with sampling being undertaken under both low flow and high flow conditions. However, the observations made in this study are deemed adequate to provide the information required to define the risk to the aquatic ecosystem in question, and to ensure that sufficient insight into management and mitigation measures is provided to adequately protect the system and to maintain the Ecostatus of the system.

[1] The Department of Water Affairs and Forestry (DWAF) was formerly known as the Department of Water Affairs (DWA). At present, the Department is known as the Department of Water and Sanitation (DWS). For the purposes of referencing in this report, the name under which the Department was known during the time of publication of reference material, will be used.

2 PROJECT DESCRIPTION

PHS Consulting has been appointed to complete a BA process for the proposed expansion of dam/s and the extension of cultivation areas (vineyards) on Portion 3 of Farm 781 which is zoned Agriculture Zone 1 and located approximately 5 km south of Bot River rural town in the Western Cape and (Figures 1-4).

The proponent has provided two (2) alternatives for consideration which are described below:

2.1 Alternative 1 (Alternative)

- **Dam 1**

The proposed expansion of Dam 1 would be an earth fill embankment with a maximum wall height of 12.5 m, total footprint area of 1.5 ha and enlarged to 35 000 m^3 storage capacity, with a new core and cut-off trench. Excavation of a new open channel spillway on the embankment left flank and the construction of a (4 m x 4 m) pump station will also be undertaken, which via a 250 mm HDPE dam outlet pipe (Class PE100 PN10) and 160 mm PVC irrigation pipe will enable irrigation of the proposed cultivation area (Figure 2).

- **Cultivation Area**

The new irrigation area would be located largely to the east of Dam 1 and be ~ 7 ha (Figure 2).

2.2 Alternative 2 (Preferred)

- **Dam 1**

The existing Dam 1 footprint would remain unchanged, while a new earth fill embankment with an open channel spillway on the embankment left bank, maximum wall height of 4.9 m, total footprint area of 0.15 ha and 2000 m^3 storage capacity is proposed immediately north east (directly downstream) of Dam 1. The construction of a (4 m x 4 m) pump station will also be undertaken, which via a 250 mm HDPE dam outlet pipe (Class PE100 PN10) and 160 mm PVC irrigation pipe will enable irrigation of the proposed cultivation area (Figure 3).

- **Dam 2**

The proposed expansion of Dam 2 would be an earth fill embankment with a maximum wall height of 4.2 m, total footprint area of 2.5 ha and enlarged to 67 000 m^3 storage capacity, with a new core and cut-off trench. Dam discharge will occur through a 250 mm HDPE outlet pipe (Class PE100 PN10), and a 315 mm HDPE overflow spillway pipe is also proposed.

- **Cultivation Area**

The new irrigation areas would consist of two portions between Dam 1 and Dam 2 and two portions beneath (east) Dam 1 and be approximately 10 ha collectively (Figure 3).

Dams 1 and 2 are currently registered for a combined storage capacity of 31 000 m^3 (6000 m^3 for Dam 1 and 25 000 m^3 for Dam 2). The expansion of the dam/s under the Alternative and Preferred development options would provide new storage capacities of 60 000 m^3 and 75 000 m^3 respectively. This constitutes ~46 % and ~58 % respectively of the annual offtake capacity (130 000 m^3/a) and is under the 60% storage allowed by the Breede Gourits Catchment Management Agency (BGCMA). The proposed dam/s would continue to store water from the Huiskloof River which is gravity fed to the dam/s via an existing 200 mm diameter HDPE pipeline from the diversion weir on the Huiskloof River ~ 2.7 km west.

Due to the proposed storage capacity of the Dam 2 being increased from 25 000 m^3 to 67 000 m^3, EA is required for construction. The new irrigation areas (vineyards) of 10 ha also trigger listed activities and therefore require a BA Report EA process.

Figure 1: A digital satellite image depicting the location of the proposed development in relation to the surrounding area.

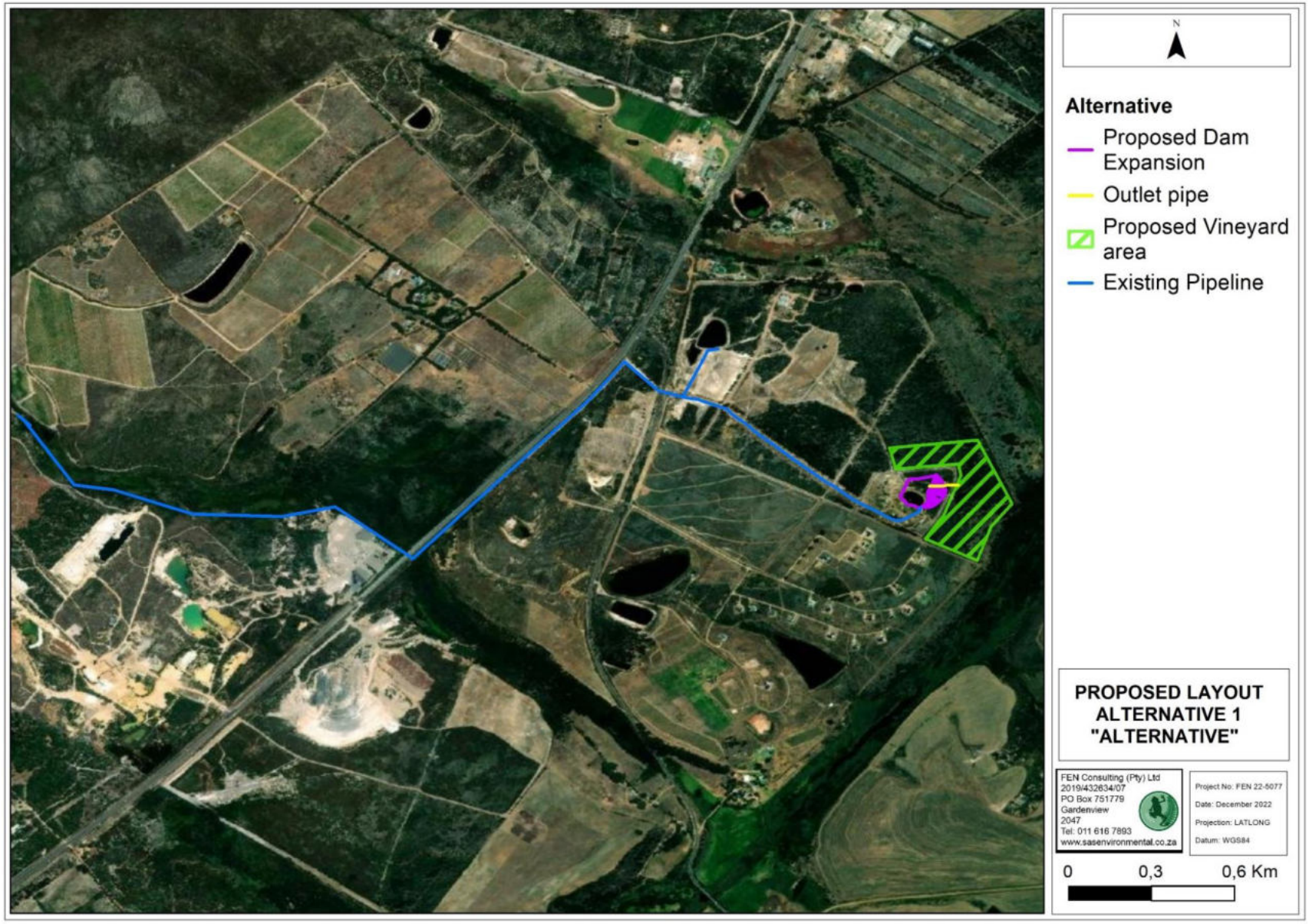


Figure 2: Proposed Alternative 1 (Alternative) layout.

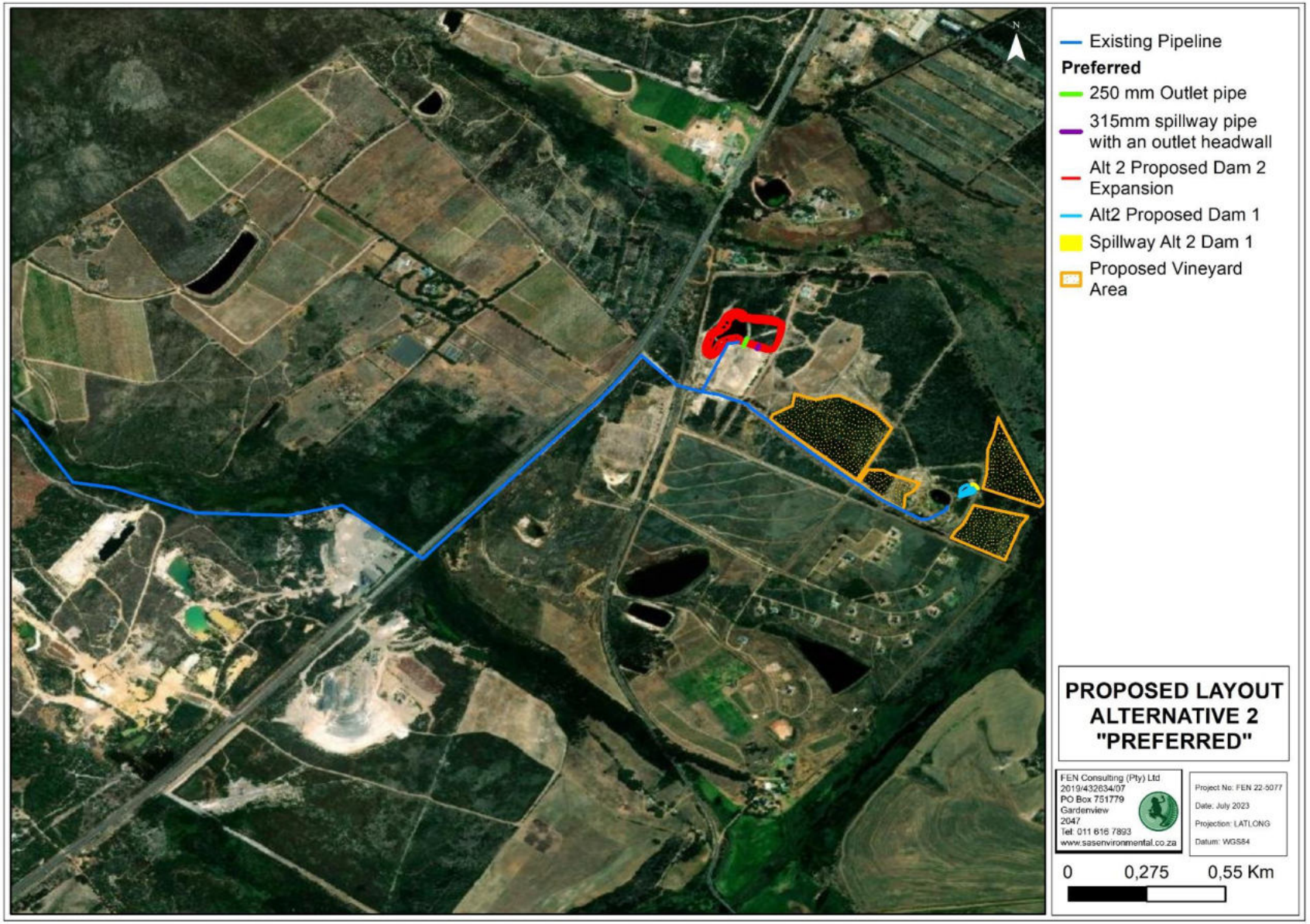


Figure 3: Proposed Alternative 2 (Preferred) layout.

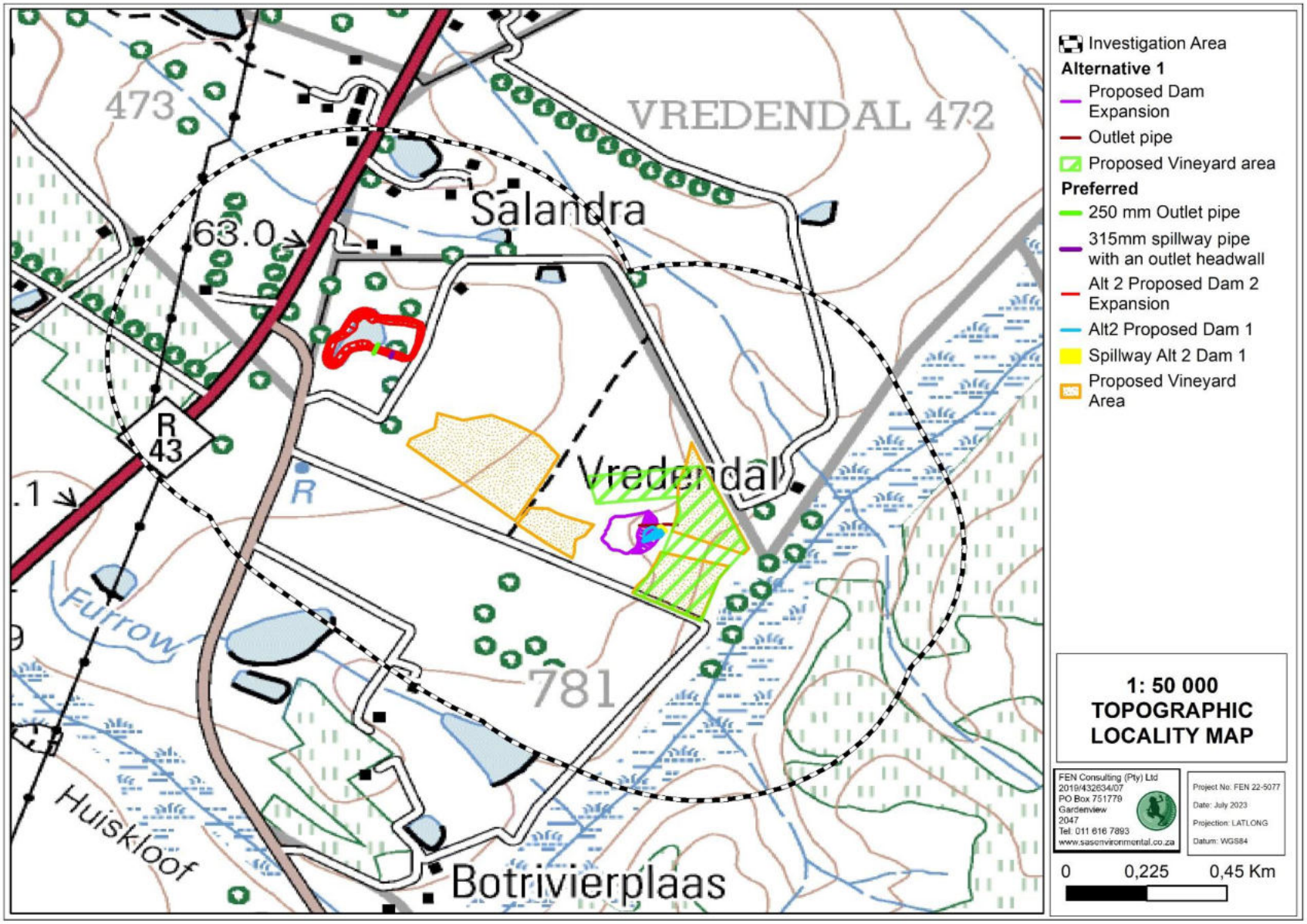


Figure 4: The proposed development alternatives depicted on a 1:50 000 topographical map in relation to the surrounding area.

3 ASSESSMENT APPROACH

3.1 Aquatic Ecological Assessment

Best practice methods of assessment (detailed methods of assessment provided in Appendix C) were used to assess the aquatic ecological integrity of the site based on water quality, instream and riparian habitat condition and biological impacts and integrity. All work was either undertaken or overseen by a South African River Health Program (SA RHP) accredited assessor. Factors investigated included the following:

- Visual conditions of the site, including an assessment of impacts on the Bot River;
- Delineation of the Riparian Zone according to (DWAF) (2008);
- Freshwater ecosystems were classified according to the Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland systems (Ollis et al., 2013);
- Water quality variables were measured *in-situ* using an ExStik EC500 and ExStik DO600 probe. Parameters included: Dissolved Oxygen (DO), pH, Electrical Conductivity (EC), Salinity and Total Dissolved Solids (TDS). The results aid in the interpretation of the data obtained by the biomonitoring. Results are discussed against the South African water quality guidelines volume 7, Aquatic ecosystems Target Water Quality Objectives (TWQR; DWAF, 1996);
- General catchment impacts were considered in the ecological assessments, such as land use, impoundments and river crossings;
- The general habitat integrity of the site was assessed through application of the Index of Habitat Integrity (IHI), based on the protocol of Kleynhans *et. al.* (2008);
- The Riparian Vegetation Response Assessment Index (VEGRAI) was assessed based on Kleynhans et al. (2008)
- The macro-invertebrate community was step wise-assessed using the following indices:
    - South African Scoring System version 5 (SASS5) as defined by Dickens & Graham (2002);
    - Invertebrate Habitat Assessment System (IHAS) according to the protocol of McMillan (1998) and
    - The Macro-Invertebrate Response Assessment Index (MIRAI) based on (Thirion 2007)
- The Ecological Importance and Sensitivity of the Bot River was determined according to the protocols of DWAF (1999).

3.2 Risk Assessment and Recommendations

Following the completion of the assessment, a risk assessment was conducted (please refer to Appendix C for the method of approach) and recommendations were developed to address and mitigate impacts associated with the proposed activities.

The recommendations provided also include general ‘best practice’ management measures, which apply to the activities associated with the proposed rehabilitation as a whole, and which are presented in Appendix D. Mitigation measures have been developed to address issues presented as a result of the proposed activities. The detailed site-specific mitigation measures are outlined in Section 7 of this report.

4 RESULTS OF THE DESKTOP ANALYSIS

4.1 Analyses of Relevant Databases

The following section contains data accessed as part of the desktop assessment and presented as a "dashboard-style" report below (Table 1). The dashboard report aims to present concise summaries of the data on as few pages as possible to allow for integration of results by the reader to take place. Where required, further discussion and interpretation are provided.

It is important to note that although all data sources used provide useful and often verifiable, high-quality data, the various databases used do not always provide an entirely accurate indication of the actual site characteristics associated with the proposed development at the scale required to inform the environmental authorisation and/or water use authorisation processes. Given these limitations, this information is considered useful as background information to the study, is important in legislative contextualisation of the risks and impacts and was thus used as a guideline to inform the assessment and to focus on areas and aspects of increased conservation importance during the field survey. It must, however, be noted that site verification of key areas may potentially contradict the information contained in the relevant databases, in which case the site verified information must carry more weight in the decision-making process.

Table 1: Desktop data relating to the character of freshwater ecosystems associated with the proposed development and surrounding region.

Aquatic ecoregion and sub-regions in which the study area is located	
Ecoregion	Southern Folded Mountains
Catchment	Berg/Bot/Potberg
Quaternary Catchment (Figure 4)	G40G
WMA	Breede
subWMA	Overberg West
Dominant characteristics of the Southern Folded Mountains Ecoregion Level II (19.06) (Kleynhans *et al.,* 2007)	
Dominant primary terrain morphology	Plains; low relief, slightly undulating plains, high mountains
Dominant primary vegetation types	Mountain Fynbos
Altitude (m a.m.s.l)	100 – 700
MAP (mm)	200 – 500
Coefficient of Variation (% of MAP)	<20 to 35
Rainfall concentration index	15 to 45
Rainfall seasonality	Winter
Mean annual temp. (°C)	16 to 18
Winter temperature (July)	4 – 20
Summer temperature (Feb)	14 – 30
Median annual simulated runoff (mm)	60 – 150

Detail of the study area in terms of the National Freshwater Ecosystem Priority Area (NFEPA) (2011) database	
FEPACODE	The study area is located within a sub-quaternary catchment that is not associated with any NFEPA sensitivity designation (FEPA CODE = 0).
NFEPA Wetlands and Rivers (Figure 5 and 6)	According to the NFEPA database, a natural floodplain wetland associated with the Bot River is located within south easter corner of the study area and eastern portion of the investigation area. There are four artificial unchanneled valley bottom wetlands located with the investigation area. All of the wetlands identified within the investigation area are considered to be in a heavily to critically modified (Class Z) ecological condition. The floodplain wetland is however identified as a FEPA wetland. The Bot River is located approximately 270 m south east of the study area, which is currently considered largely modified (Class D). Dam 2 is considered to be a wetland flat.
Wetland Vegetation Type	The study area is situated within the East Coast Shale Renosterveld (Critically Endangered) wetland vegetation type. The threat status is provided by Mbona *et al*. (2015).

Detail of the study area in terms of the National Biodiversity Assessment (2018) (Figure 8)

According to the NBA (2018) database, no freshwater ecosystems occur within the study area, however there is a floodplain wetland associated with the Bot River within the investigation area, which corresponds with the NFEPA Dataset (2011) which is considered heavily to critically modified (Class DEF). The Ecosystem Threat Status (ETS) of the floodplain wetland is critically endangered and the wetland is poorly protected according to the Ecosystem Protection Level (EPL). According to the NBA (2018) database, the Bot River is largely modified (Class D), critically endangered (ETS) and currently not protected (EPL). A channelled valley bottom wetland occurs within the investigation area which according to the NBA (2018) database is in a moderately modified ecological condition (Class C) with an ETS and EPL of critically endangered and poorly protected respectively.

Detail of the study area in terms of the Western Cape Biodiversity Spatial Plan (WCBSP) (2017) (Figure 7)

According to the Western Cape Biodiversity Spatial Plan (2017), the entire proposed Alternative and Preferred development layouts and the north western portion of the proposed vineyard (Alternative option) are situated within a category 2 Critical Biodiversity Area (CBA) for terrestrial. The Bot River is identified as a Category 1 CBA River and the associated floodplain wetland is identified as a CBA 1 and ESA 2 (restore from other landuse).

CBAs are areas in a natural condition that are required to meet biodiversity targets, for species, ecosystems or ecological processes and infrastructure. CBAs are areas of high biodiversity and ecological value and need to be kept in a natural or near-natural state, with no further loss of habitat or species. Degraded areas should be rehabilitated to natural or near-natural condition. Only low-impact, biodiversity-sensitive land uses are appropriate. A distinction is made between CBAs that are likely to be in a natural condition (CBA 1) and those that are potentially degraded or represent secondary vegetation (CBA 2).

ESA areas are important in supporting the functioning of CBA's and are often vital for delivering ecosystem services and are areas that are not essential for meeting biodiversity targets, but play an important role in supporting the functioning of Protected Areas (PAs) or CBAs and are often vital for delivering ecosystem services. They support landscape connectivity, encompass the ecological infrastructure from which ecosystem goods and services flow, and strengthen resilience to climate change. They include features such as regional climate adaptation corridors, water source and recharge areas, riparian habitat surrounding rivers or wetlands, and Endangered vegetation. ESAs need to be maintained in at least a functional and often natural state, in order to support the purpose for which they were identified, but some limited habitat loss may be acceptable. A distinction is made between ESAs that are still likely to be functional (i.e. in a natural, near-natural or moderately degraded condition; ESA 1), and Ecological Support Areas that are severely degraded or have no natural cover remaining and therefore require restoration (ESA 2).

Although not part of the WCBSP 2017 database, it should further be noted that the Bot River Estuary is a short distance (~ 9 km) downstream and is a Ramsar Wetland of International Importance.

National web based environmental screening tool (Department of Forestry, Fisheries and the Environment 2022)	
The screening tool is intended for pre-screening of sensitivities in the landscape for assessment within the EIA process and assists with implementing the migration hierarchy, allowing developers to adjust their proposed development footprint to avoid sensitive areas.	The study and investigation areas fall within a very high aquatic biodiversity sensitivity area due to the presence of aquatic CBAs and being located within the Boland surface water and Southwestern Cape Ranges groundwater Strategic Water Source Areas (SWSA). The SWSA for groundwater (SWSA-gw) reflect areas that have high groundwater recharge and where the groundwater forms a nationally important resource. The areas are delineated for the purposes of research, and the outcomes are useful to national level planners and decision makers as an indication of the location of strategic groundwater sources and resources. Sub-national WSAs for groundwater were also identified. Surface water SWSAs are defined as areas of land that supply a disproportionate (i.e., relatively large) quantity of mean annual surface water runoff in relation to their size. They include transboundary areas that extend into Lesotho and Swaziland. The sub-national WSAs are not nationally strategic as defined in the report but were included to provide complete coverage.

CBA = Critical Biodiversity Areas; DWS = Department of Water and Sanitation; EI = Ecological Importance; ES = Ecological Sensitivity; ESA = Ecological Support Area; m.a.m.s.l = Meters Above Mean Sea Level; MAP = Mean Annual Precipitation; NFEPA = National Freshwater Ecosystem Priority Areas; WMA = Water Management Area

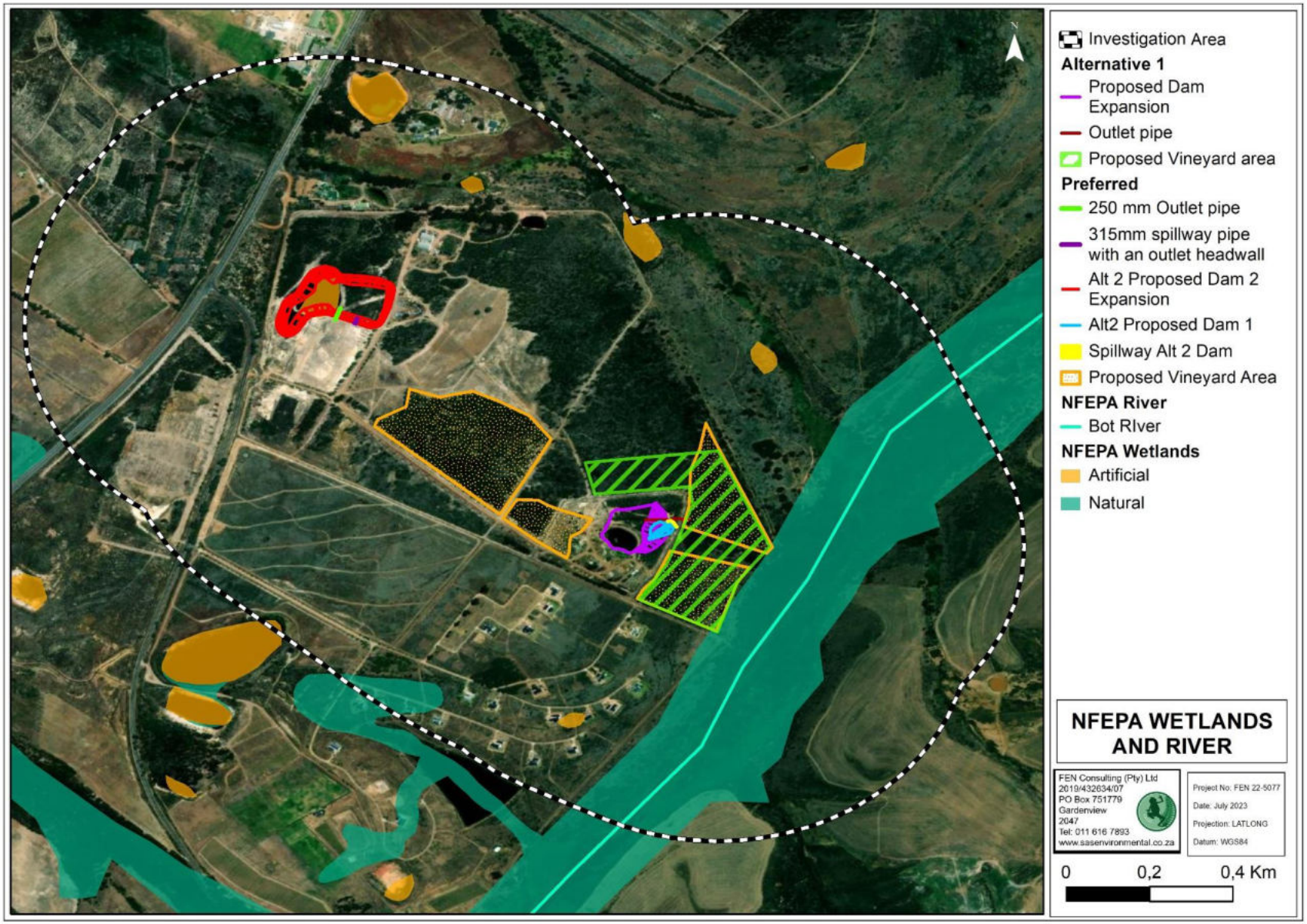


Figure 5: The proposed development alternatives in relation to the NFEPA wetlands (artificial and natural) and river database (2011), within the investigation area.

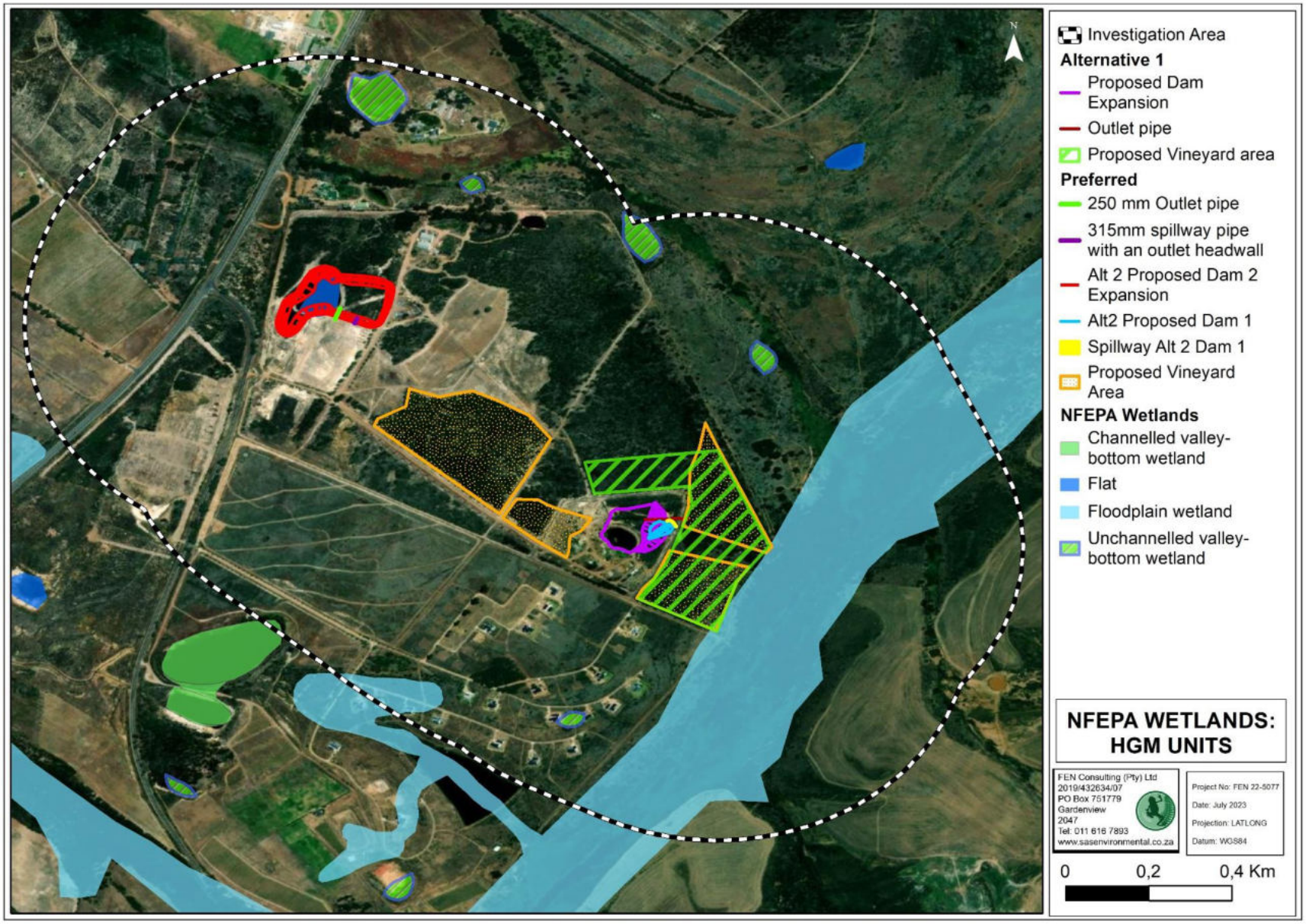


Figure 6: The proposed development alternatives in relation to the NFEPA wetlands (HGM type) and river database (2011), within the investigation area.

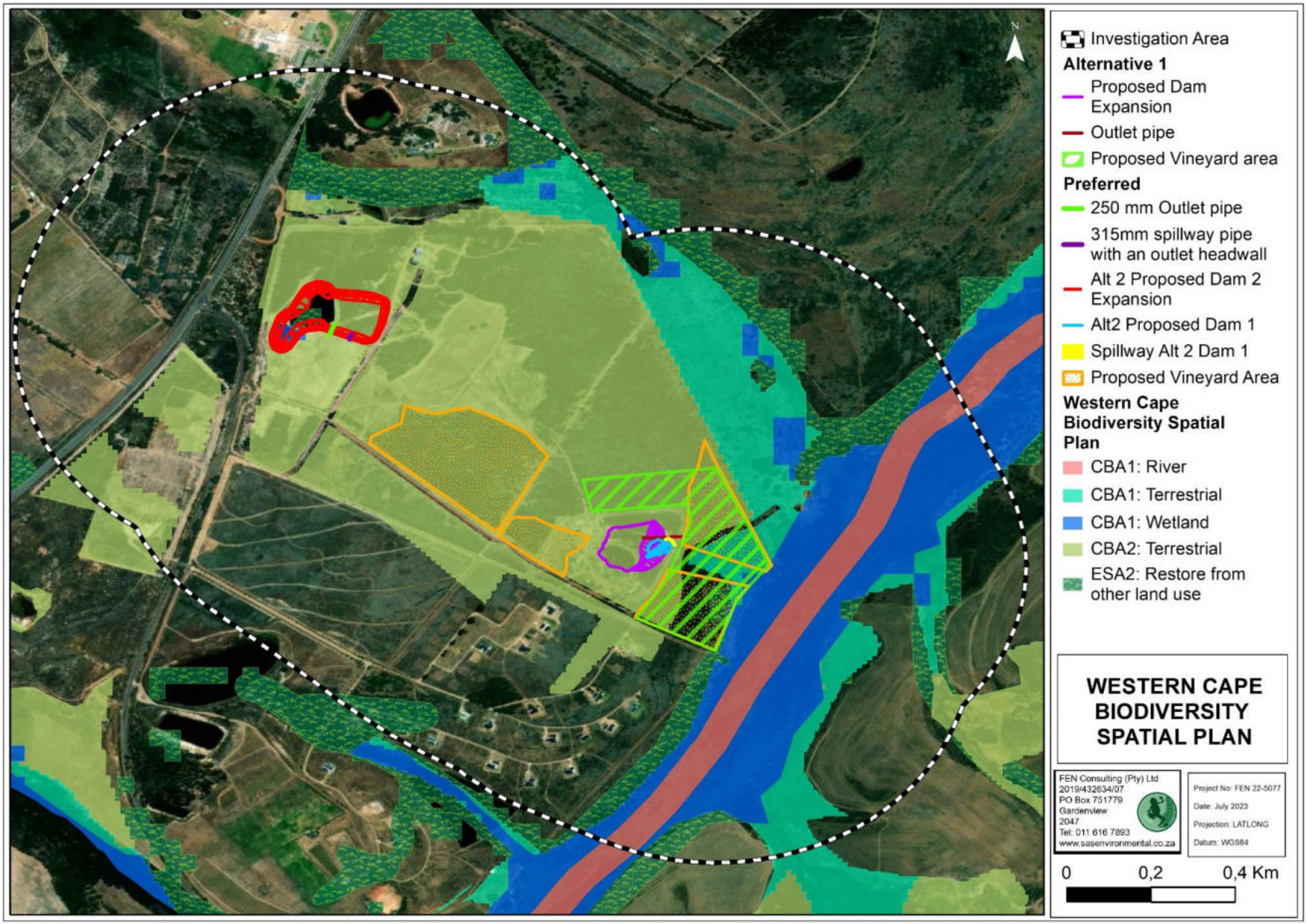


Figure 7: The proposed development alternatives in relation to the Western Cape Biodiversity Spatial Plan (2017), within the investigation area.

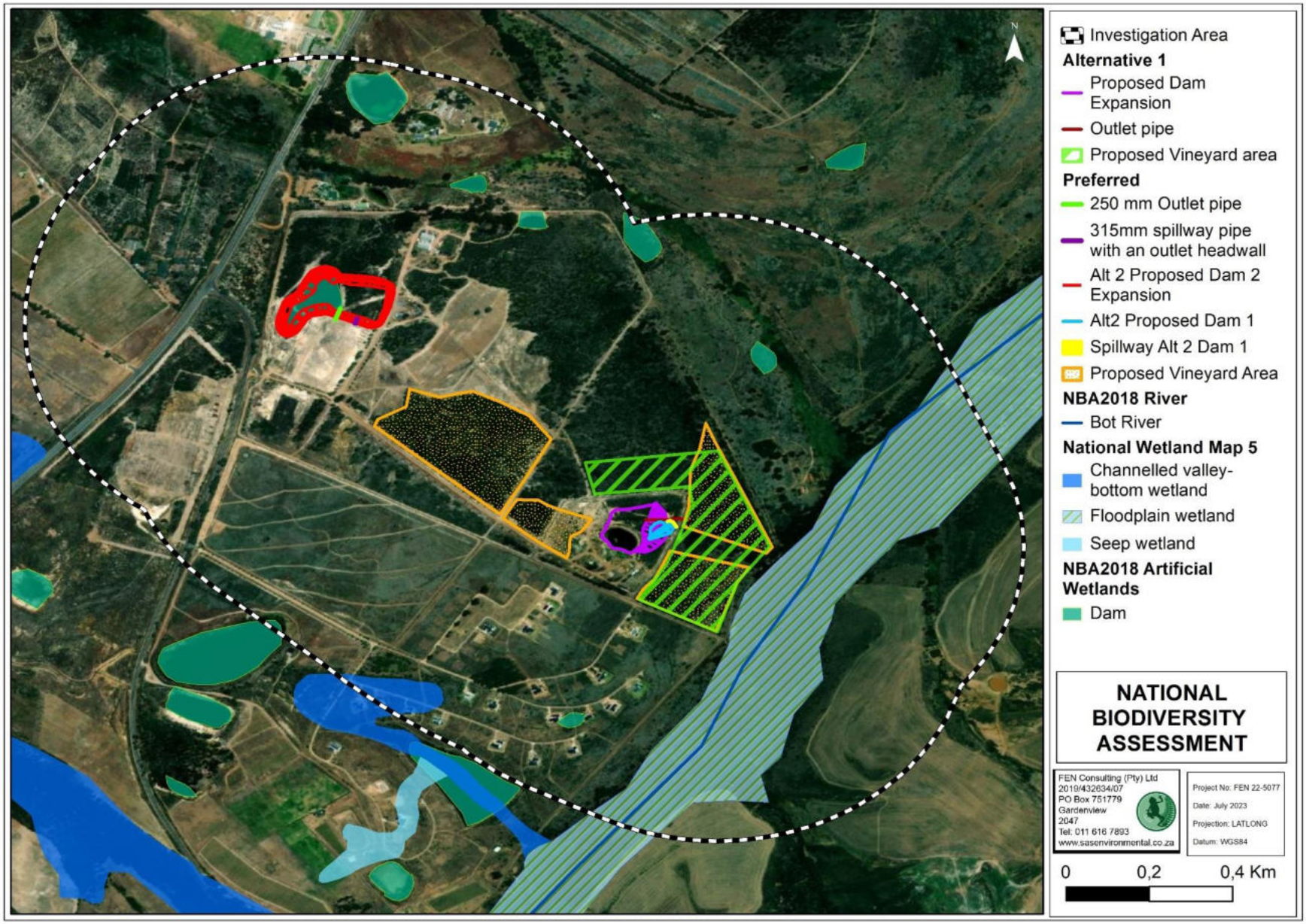


Figure 8: The proposed development alternatives in relation to the National Biodiversity Assessment (2018), within the investigation area.

4.2 Ecostatus

4.2.1 Ecological Status of Sub-quaternary Catchments [Department of Water and Sanitation (DWS) Resource Quality Information Services (RQIS) PES/EIS Database]

The PES/EIS database, as developed by the DWS RQS department, was utilised to obtain additional background information on the project area. The information from this database is based on information at a sub-quaternary catchment reach (SQR) level with the descriptions of the aquatic ecology based on the information collated by the DWS RQIS department from all reliable sources of reliable information such as the South Africa River Health Programme (SA RHP) sites, Ecological Water Requirements (EWR) sites and Hydro Water Management System (WMS) sites.

Key information on background conditions associated with the proposed development, as contained in this database and pertaining to the PES and EIS for the SQR G40G – 09370 (Bot River) are tabulated in Table 2 and indicated in Figure 7 below.

The data for SQR G40G – 09370 (Bot River) indicates that no fish species occur at this site and the following macro-invertebrate species are expected to occur at this site:

Oligochaeta	Coenagrionidae
Amphipoda	Lestidae
Potamonautidae	Aeshnidae
Hydracarina	Gomphidae
Notonemouridae	Libellulidae
Perlidae	Corixidae
Baetidae 1 Sp	Notonectidae
Baetidae 2 Sp	Veliidae/Mesoveliidae
Caenidae	Hydropsychidae 1 Sp
Leptophlebiidae	Philopotamidae
Teloganodidae	Barbarochthonidae
Synlestidae/Chlorolestidae	Leptoceridae
Oligochaeta	Coenagrionidae
Amphipoda	Lestidae
Potamonautidae	Aeshnidae
Hydracarina	Gomphidae
Notonemouridae	Libellulidae
Perlidae	Corixidae
Baetidae 1 Sp	Notonectidae
Baetidae 2 Sp	Veliidae/Mesoveliidae
Caenidae	Hydropsychidae 1 Sp
Leptophlebiidae	Philopotamidae
Teloganodidae	Barbarochthonidae
Synlestidae/Chlorolestidae	Leptoceridae

Table 2: Summary of the ecological status of the sub-quaternary catchment (SQ) reach G40G-09370 (Bot River) on the DWS RQS PES/EIS database.

	G40G – 09370 (Bot River)
Synopsis	
PES Category Median	Largely Modified
Mean EI class	Moderate
Mean ES class	Very High
Length	4.41
Stream order	3
Default EC[4]	A (Very High)
PES Details	
Instream habitat continuity MOD	Moderate
RIP/wetland zone continuity MOD	Large
Potential instream habitat MOD activities	Large
Riparian/wetland zone MOD	Large
Potential flow MOD activities	Moderate
Potential physico-chemical MOD activities	Large
EI Details	
Fish spp/SQ	NA
Fish average confidence	NA
Fish representivity per secondary class	NA
Fish rarity per secondary class	NA
Invertebrate taxa/SQ	36
Invertebrate average confidence	5.00
Invertebrate representivity per secondary class	High
Invertebrate rarity per secondary class	Very High
EI importance: riparian-wetland-instream vertebrates (excluding fish) rating	Very High
Habitat diversity class	Very Low
Habitat size (length) class	Very Low
Instream migration link class	High
Riparian-wetland zone migration link	Moderate
Riparian-wetland zone habitat integrity class	Moderate
Instream habitat integrity class	Moderate
Riparian-wetland natural vegetation rating based on percentage natural vegetation in 500m	High
Riparian-wetland natural vegetation rating based on expert rating	High
ES Details	
Fish physical-chemical sensitivity description	NA
Fish no-flow sensitivity	NA
Invertebrates physical-chemical sensitivity description	Very High
Invertebrates velocity sensitivity	Very High
Riparian-wetland-instream vertebrates (excluding fish) intolerance water level/flow changes description	High
Stream size sensitivity to modified flow/water level changes description	Very High
Riparian-wetland vegetation intolerance to water level changes description	High

[1] PES = Present Ecological State; confirmed in database that assessments were performed by expert assessors;
[2] EI = Ecological Importance;
[3] ES = Ecological Sensitivity
[4] EC = Ecological Category; default based on median PES and highest of EI or ES means.

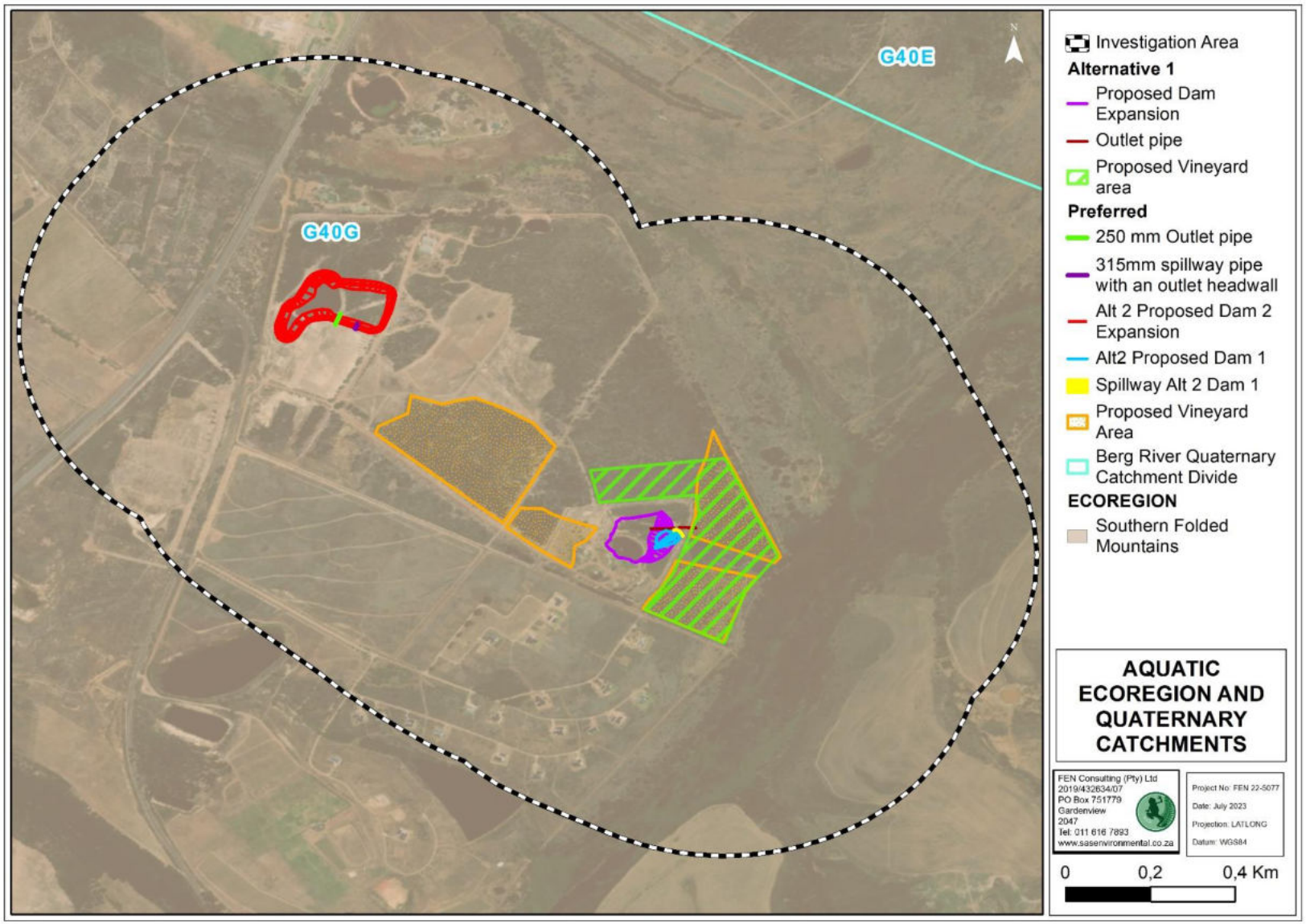


Figure 9: Aquatic Ecoregion and Quaternary Catchment in the vicinity of the proposed development within the investigation area.

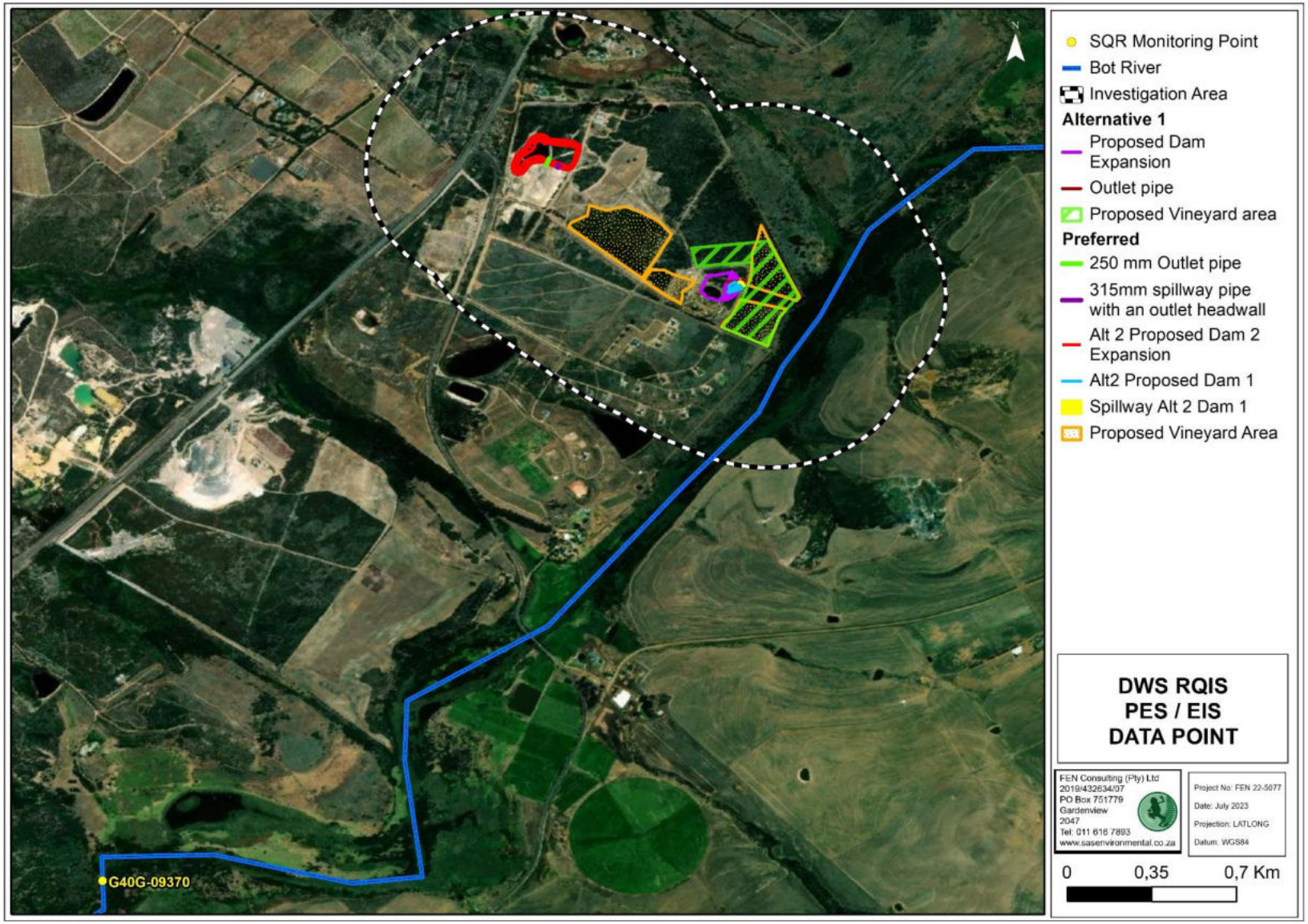


Figure 10: DWS RQIS PES EIS data monitoring point in the vicinity of the investigation area.

5 RESULTS

5.1 Freshwater Assessment

Field verification of the study area confirmed that the proposed Dam 1 expansion area was recently deforested sometime after April 2021 and currently presents as cleared, highly disturbed land (Figure 11 A) subjected to erosion, weed infestations (*Athanasia crithmifolia*) and alien trees such as *Eucalyptus* sp. (Blue Gum), *Pinus pinaster* (Pine) and *Acacia saligna* (Black wattle).

The proposed expansion of the Dam 1 (Alternative 1) overlies an area in which a persistent linear freshwater feature was observed using historic aerial photography since 1979 (Figure 11). The field verification and historic aerial photography confirmed that the linear freshwater feature (identified as an artificial drainage line) originates from historic and ongoing upgradient deforestation (compare Figure 11 A to Figure 11 B), providing unattenuated overland surface flow that has collected in a valley north east of the proposed dam expansion area. Facultative vegetation observed within the proposed dam expansion area are deemed an artificial wet response confined to drainage lines (Figure 12 B-C) created by the dam outflow scheme, which drains into the linear drainage line further downgradient (Figure 12 E-F). The proposed dam expansion area indicated no signal of prolonged wetness (Figure 12 D) required for the fomation of freshwater ecosystems, despite the valley floor terrain in which freshwater ecosystems typically form. No natural freshwater ecosystems thus exist within the proposed Dam 1 expansion area (Alternative 1), or newly proposed dam area, directly downgradient of Dam 1 (Alternative 2). Similarly, the area proposed for vineyard cultivation is an alien infested terrestrial area and also poses no restriction to the development of the vineyard (Figure B in management summary).

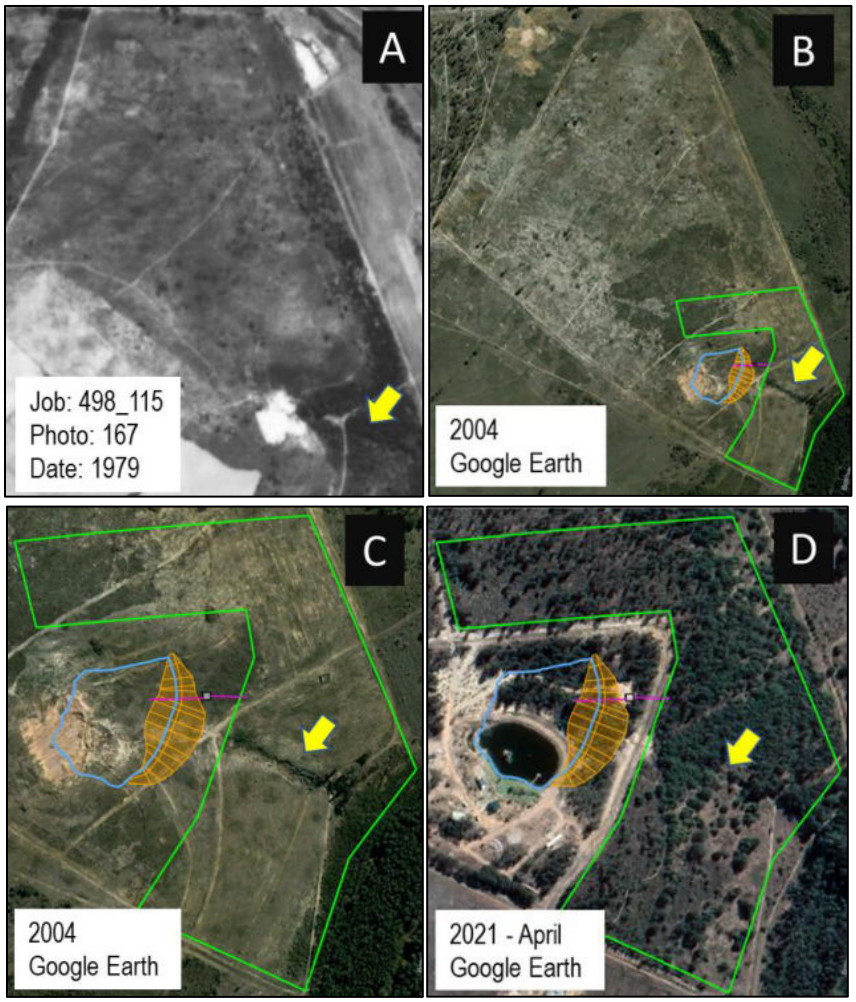


Figure 11: History of the artificial drainage line, illustrating its footprint (yellow arrow) in 1979 (A) and again in 2004 (B-C) and 2021 (D). Notice the upgradient deforestation already evident in 1979 (A) which has become more pronounced in 2004 (B). Alternative 1 shown here.

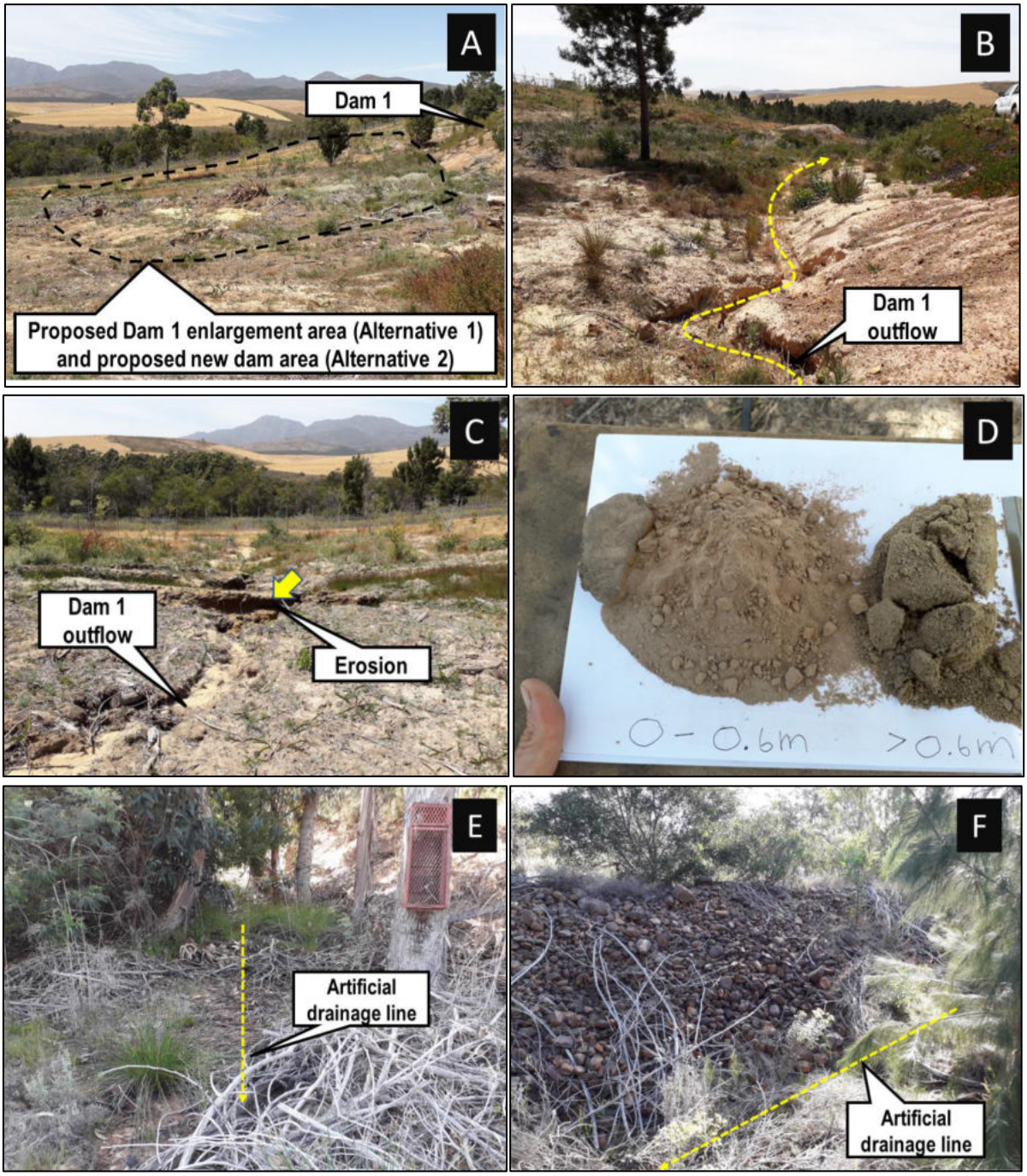


Figure 12: Field observations illustrating A) the proposed dam expansion area (Alternative 1) which also encompasses the proposed new dam area (Alternative 2) on highly disturbed land, B) dam outflow, C) erosion within the dam outflow drainage line, likely also from sheet flow upgradient to deforestation, D) soil auger sample from the proposed dam expansion area, E) dam outflow artificial drainage line further downgradient outside of the study area and, F) a cobble berm to constrict the artificial drainage line further downgradient of the proposed dam.

Dam 2 consists of dense (mostly impenetrable) stands of alien invasive trees such as (*Pinus pinaster)* Pine, (*Acacia saligna*) Port Jackson and (Eucalyptus spp.) Bluegum and very little natural vegetation remains among these trees (see Figure B in management summary – photo E).

5.2 Aquatic Assessment

5.2.1 Site characteristics

The assessed point of the Bot River displayed relatively deep depths (> 0.5m to 1m) in the spring season of November 2022 with the flow presenting as a barely perceptible, opaque, odourless run. Access to the river channel requires wading through a dense non-marginal riparian zone infested primarily by *Eucalyptus* spp. (Blue Gum) and *Acacia mearnsii* (Black Wattle) and the river bank has been built up by sediment and stabilised by obligate vegetation such as *Cyperus textilis*, *Isolepis prolifera*, *Persicaria lapathifolia* and *Phragmites australis* (Figure 13).

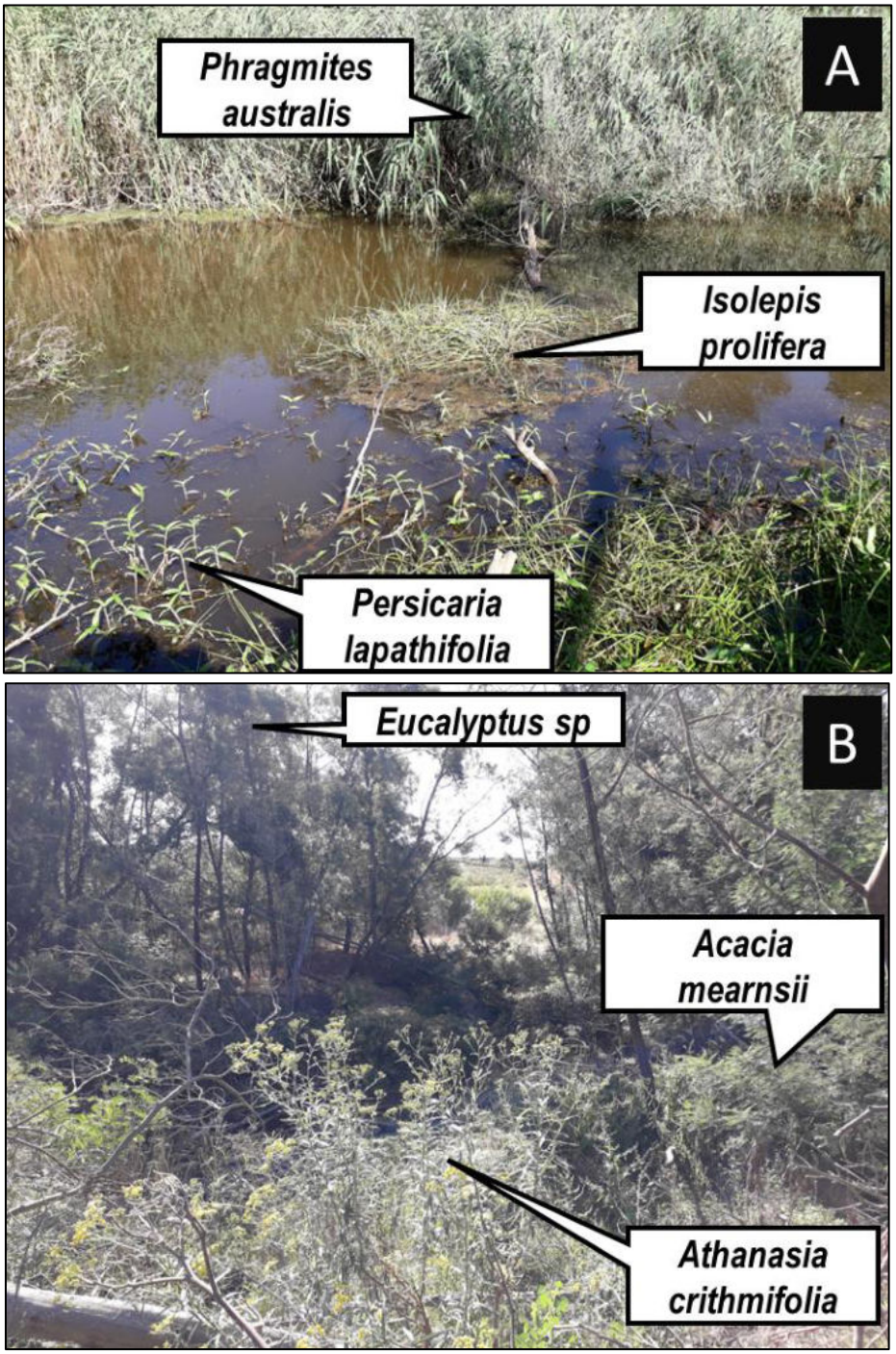


Figure 13: Instream and the riparian zone of the Bot River, illustrating serious instream sedimentation and riparian alien infestation.

5.2.2 Ecological Importance and Sensitivity Assessment

The Ecological Importance and Sensitivity (EIS) method (DWAF, 1999) was applied to the Bot River to ascertain the current sensitivity and importance of the system. The result of the assessment is presented in Table 3 below:

Table 3. Results of the EIS assessment for the Bot River within the investigation area.

ECOLOGICAL IMPORTANCE & SENSITIVITY - Bot River		
CRITERIA	**EIS Scores**	**Confidence**
BIOTIC		
Rare & endangered biota	1	High
Unique biota	2	Medium
Intolerant (i.e. sensitive) biota	2	High
Species/taxon richness	2	High
Median score (Biotic criteria)	**2** **(HighEIS)**	**Medium**
HABITAT		
Diversity of aquatic habitat types	2	Medium
Refuge value of habitat types	3	Medium
Sensitivity of habitat to flow changes	2	Medium
Sensitivity of habitat to WQ changes	1	Medium
Migration route/corridor	4	High
Protected/natural areas	4	High
Median score (Habitat criteria)	**2.5** **Very High EIS)**	**Medium**
Overall median score	**2.3** **(High EIS)**	**Medium**

The EIS assessment analysis of the Bot River provided an overall median score of 2.5 which translates to a **High Ecological Importance and Sensitivity.** The Bot River is therefore associated with features that are considered unique on a national scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) may be sensitive to flow modifications but may have a substantial capacity for use.

The high EIS of the Bot River stems primarily from aquatic macroinvertebrate metrics (rarity, representivity, physical-chemical and velocity sensitivity), and habitat metrics (instream migration link class, stream size sensitivity to modified water level changes and riparian-wetland vegetation intolerance to water level changes). It must also be noted that the Bot River is recognised as a CBA1 in the provincial WCBSP dataset and is also recognised in the national 2011 NFEPA and 2018 National Biodiversity Assessment databases affording it a high level of protection.

It should further be noted that the Bot River Estuary is a short distance (~ 9 km) downstream and is a Ramsar Wetland of International Importance.

Overall instream integrity of the Bot River was determined using to the following *in situ* assessments:

- River IHI;
- VEGRAI;
- SASS5;
- IHAS;
- MIRAI;
- Diatom community analysis; and
- *in situ* physico-chemistry

The results of the above instream integrity assessments are summarised below in Table 4.

Table 4: Results of the aquatic assessment of the Bot River.

Diatom Community Analysis

Dam (Medium = cobbles)

Dominant Specie 1: *Eunotia minor*
Occurs in circumneutral waters, in pools and springs.

Dominant Specie 2: *Navicula* spp.
Cosmopolitan species occurring in wide variety of waters ranging from humic, weakly acidic, oligotrophic, electrolyte poor to strongly alkaline, eutrophic and calcareous. Species very sensitive to organic pollution.

Diatom Index Scores

SPI	GDI	TDI	%PTV
11.2	12.3	12.2	10

Trophic level	Ecosystem Quality	Ecological category
Meso-eutrophic	Moderate quality	C/D

Bot River (Medium = Plants)

Dominant Specie 1: *Melosira varians*
Cosmopolitan taxon found in benthos and plankton, particularly abundant in eutrophic/occasionally slightly brackish waters.

Dominant Specie 2: *Fragilaria ulna*
Cosmopolitan taxon found in benthos of rivers and lakes and easily suspended in the plankton due to relatively large surface area. Found in mesotrophic to eutrophic, alkaline freshwaters. Living cells usually apically attached to substratum.

Diatom Index Scores

SPI	GDI	TDI	%PTV
12.1	11.8	9.2	0

Trophic level	Ecosystem Quality	Ecological category
Mesotrophic	Moderate Quality	C
Depth profiles	Moderately deep. > 0.5m to 1m.	
Flow condition	Very slow opaque run of barely perceptible flow.	
Riparian zone characteristics	Very dense riparian zone consisting of *Cyperus textilis*, *Phragmites australis, Persicaria lapathifolia* and *Isolepis prolifera* in the marginal zone and alien invasive trees such as *Eucalyptus* sp. (Blue Gum) and *Acacia mearnsii* (Black Wattle) in the non-marginal zone.	
Odour:	none	
Signs of pollution	No organic pollution based on diatom assemblage. Inorganic pollution elevated based on EC, TDS, Salinity and DO.	
Significance	Site aquatic indices and *in situ* physico-chemistries indicate decreased flows, elevated sedimentation and moderate Eutrophication which reflects agricultural activities in the upgradient catchment.	

In situ physico-chemical water quality

Parameter	Dam 1	Bot River	RWQO
pH	6.49	6.97	Not available for quaternary catchments concerning the Bot River
EC (mS/m)	34.5	126	
TDS (mg/L)	240	892	
Salinity (ppm)	158	630	
DO (mg/L)	5.79	3.80	
DO (% sat)	77%	55.5	

Water Quality Comments

- All pH values fall within natural limits and are typical of acidic-leached rivers draining through Fynbos in the Western Cape;
- Electrical Conductivity (EC) in undisturbed rivers is 30 mS/m, indicating significant salt input into the Bot River (126 mS/m);
- The Total Dissolved Solids (TDS) concentration (which relates to the EC) was also significantly higher in the Bot River (892 mg/L) compared to in Dam 1 (240 mg/L);
- Salinity was significantly higher in the Bot River (630 mg/L) compared to in Dam 1 (158 mg/L);
- Dissolved Oxygen (DO) is considered very low in the Bot River (3.80 mg/L) and falls below the 80% saturation recommendation (DWAF, 1996) and
- Overall water quality of the Bot River was considered poor, and of a poorer quality compared to the water quality of Dam 1.

Index of Habitat Integrity

Instream IHI: 50.1 (Category D)	Riparian IHI: 35.1 (Category E)

The majority of the upstream catchment of the Bot River study site is agriculturally transformed, which has necessitated the impounding of many of its first and second order streams, resulting in a moderate decrease in base flows and floods. The loss of vegetation cover to agriculture also causes an increase in catchment evaporation and an unnaturally high sediment load into this river system. Catchment land use dictates poor river physico-chemistry which was confirmed by *in situ* measurements. The additional sediment input combined with a decrease in river flow has created a self-perpetuating sedimentation complication of the river channel, and is enjoyed by opportunistic *Phragmites australis* reeds. Additional nutrient input combined with decreased flows has caused eutrophication of the instream channel, as observed by numerous green algal clumps. The riparian zone has lost some connectivity with the river channel due to the moderate decrease in hydrological inputs from the upstream catchment.

Aquatic macro-invertebrate community integrity

Macro-invertebrate sampling was only conducted for the vegetation and muddy biotope considering that stones in and out of current, gravel and sand were not present at the sampling reach. The aquatic macroinvertebrate community is however considered well presented in the vegetation biotope and of this reach overall, given the habitat characteristics and availability of various vegetation types (leafy versus sedgy) and algal mats. Dominance of the community by air breathing taxa is consistent with the low DO concentration.

Invertebrate Habitat Assessment System (IHAS)

Habitat Total Score (%)	51%
Stream Condition Total Score (%)	64%
Total IHAS Score	57% (Fair)

South African Scoring System – Version 5 (SASS5)

Biotope	SASS Score	Families	ASPT	PES
Total Score	**100**	**20**	**5**	**B**

Macro-Invertebrate Response Assessment Index (MIRAI)

Flow Modification Score	13.8923
Habitat Score	29.6923
Water Quality	10.4
Connectivity and Seasonality	12
Invertebrate EC	65.9846
Invertebrate EC Category	C (Moderately Modified)

Riparian Vegetation Assessment Index (VEGRAI)

VEGRAI score: 40.0 (Category D/E)
A low VEGRAI score was determined based on the infestation by alien invasive vegetation such as *Eucalyptus* spp. and *Acacia mearnsii* in the non-marginal zone and the decrease in longitudinal and lateral connectivity due to the decrease in river base flows and floods.

River Ecostatus Summary

No DWS RWQO is available for the Bot River, but considering the outcome of the various aquatic ecological assessments, the overall River Ecostatus of the Bot River is deemed to be Largely Modified (PES Class = D).

Key Drivers of System Change

- The key drivers of change are the decrease in baseflows and floods, coupled with an increase in sediment loads into the river which act together to promote sedimentation of the river channel, decrease water quality, promote eutrophication and impair the integrity of the instream and riparian habitats;
- In terms of trophic food webs, the low dissolved oxygen has promoted a predatory air-breathing aquatic macroinvertebrate community, with other important functional feeding groups such as deposit feeders of detritus and algae largely absent, disrupting the transfer of carbon to higher trophic levels.

6 LEGISLATIVE REQUIREMENTS

The following legislative requirements were considered during the assessment. A detailed description of these legislative requirements is presented in Appendix B of this report:

- The Constitution of the Republic of South Africa, 1996[2];
- The National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA);
- The National Water Act, 1998 (Act No. 36 of 1998) (NWA);
- Government Notice 509 as published in the Government Gazette 40229 of 2016 as it relates to the National Water Act, 1998 (Act No. 36 of 1998).

According to Macfarlane *et al.* (2015) the definition of a buffer zone is variable, depending on the purpose of the buffer zone, however, it is considered to be "a strip of land with a use, function or zoning specifically designed to protect one area of land against impacts from another". Buffer zones are considered to be important to provide protection of basic ecosystem processes (in this case, the protection of aquatic and wetland ecological services), reduce impacts on water resources arising from upstream activities (e.g. by removing or filtering sediment and pollutants), provision of habitat for aquatic and wetland species as well as for certain terrestrial species, and a range of ancillary societal benefits (Macfarlane *et. al,* 2015). It should be noted, however, that buffer zones are not considered to be effective mitigation against impacts such as hydrological changes arising from stream flow reduction, impoundments or abstraction, nor are they considered to be effective in the management of point-source discharges or contamination of groundwater, both of which require site-specific mitigation measures (Macfarlane *et. al,* 2015).

The definition and motivation for a regulated zone of activity for the protection of freshwater ecosystems can be summarised as follows:

Table 5: Articles of legislation and the relevant zones of regulation applicable to each article.

Regulatory authorisation	Zone of applicability
Water Use License Application in terms of the National Water Act, 1998 (Act No. 36 of 1998). ***Department of Water and Sanitation***	In accordance with General Notice 509 of 2016, a regulated area of a watercourse for section 21 (c) and 21 (i) of the National Water Act, 1998 (Act 36 of 1998) is defined as: • the outer edge of the 1 in 100 year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam; • in the absence of a determined 1 in 100 year flood line or riparian area the area within 100 m from the edge of a watercourse where the edge of the watercourse is the first identifiable annual bank fill flood bench; or • a 500m radius from the delineated boundary (extent) of any wetland or pan.
Listed activities in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998). ***Department of Environmental Affairs and Development Planning***	The EIA Regulations (2014), as amended in April 2017, must be taken into consideration if any activities (for example, stockpiling of soil) are to take place within the applicable zone of regulation. This must be determined by the EAP in consultation with the relevant authorities.

In accordance with the above legislation, a 32 m Zone of Regulation (ZoR) under with the National Environmental Management Act, 1998 (Act No. 107 of 1998) was applied to all freshwater ecosystems in the investigation area and a 100 m and 500 m ZoR in accordance with GN509 under the National Water Act, 1998 (Act No. 36 of 1998) was applied to the Bot River and unchanneled valley bottom wetland respectively. The freshwater ecosystem delineation map is illustrated in Figure 14 and the zones of regulation map in Figure 15.

[2] Since 1996, the Constitution has been amended by seventeen amendments acts. The Constitution is formally entitled the 'Constitution of the Republic of South Africa, 19996". It was previously also numbered as if it were an Act of Parliament – Act No. 108 of 1996 – but since the passage of the Citation of Constitutional Laws Act, neither it nor the acts amending it are allocated act numbers.

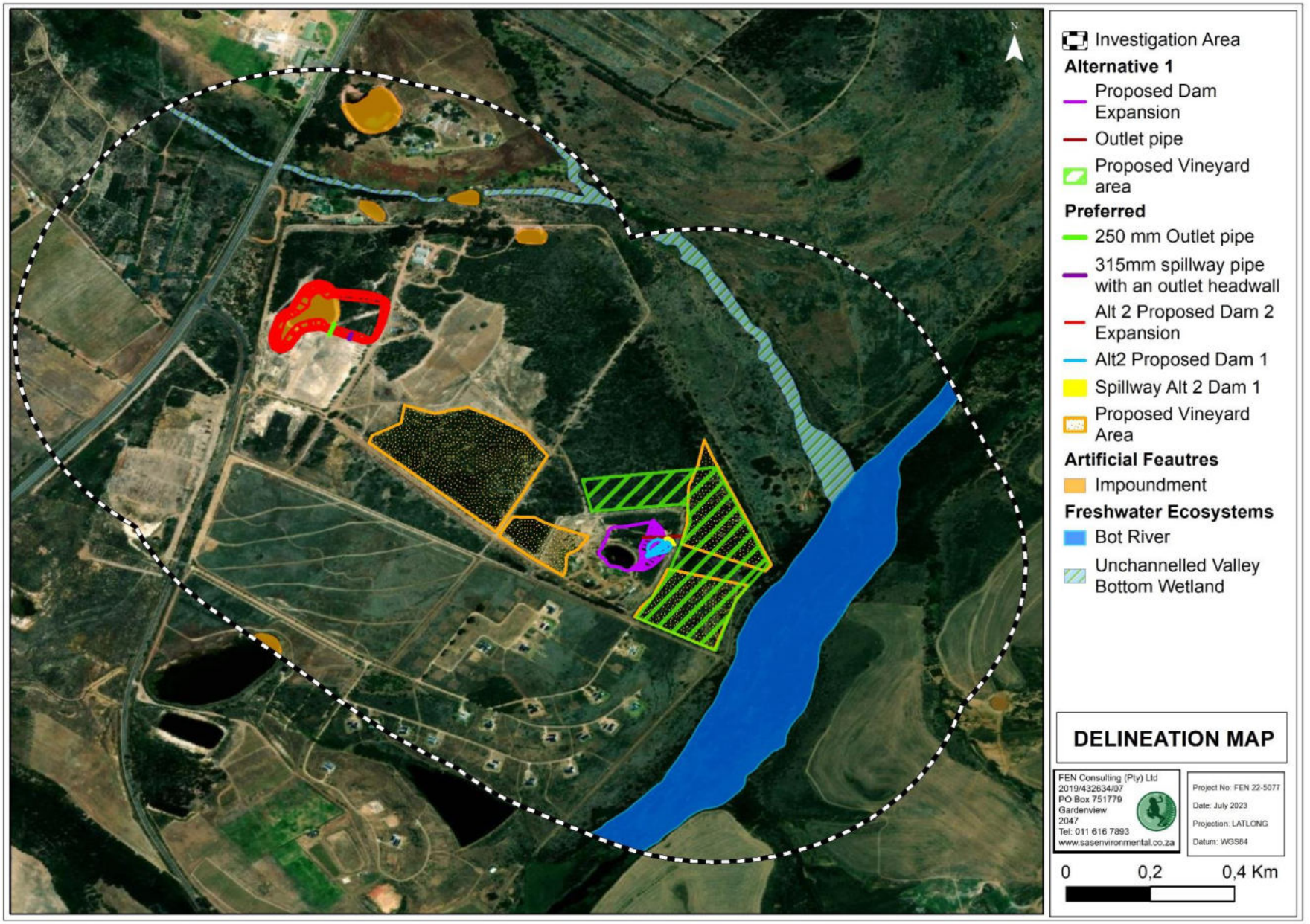


Figure 14: Delineated extent of freshwater ecosystems falling within the investigation area around the proposed development alternatives.

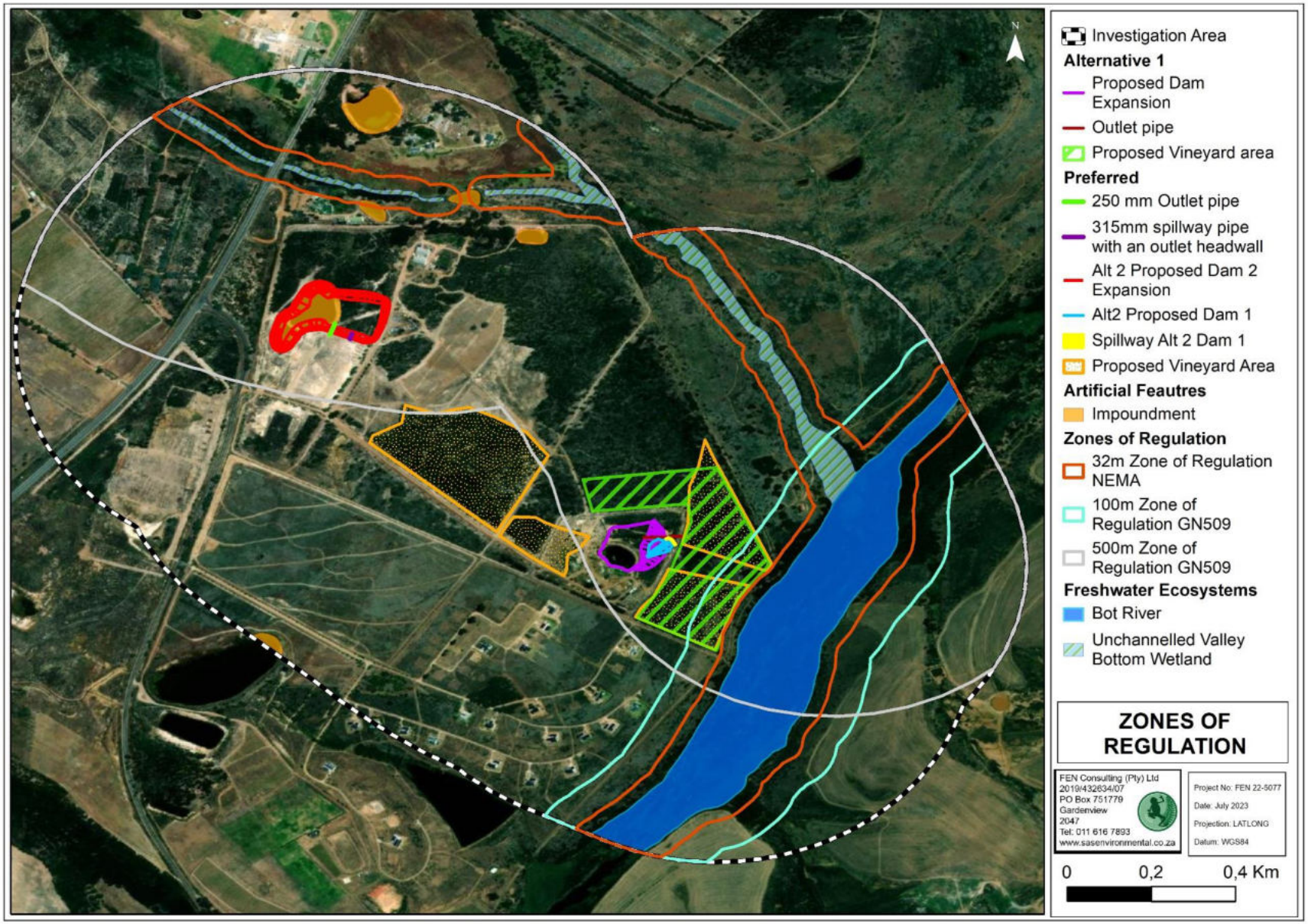


Figure 15: Delineated extent of freshwater ecosystems falling within the investigation area around the proposed development, alternatives including their applicable zones of regulation under the NWA and NEMA.

7 RISK ASSESSMENT

Following the aquatic assessment of the Bot River, the DWS specified Risk Assessment Matrix (as promulgated in GN509 of 2016) was applied to ascertain the significance of risk associated with the individual activities on the key drivers and receptors (hydrology, water quality, geomorphology, habitat and biota) of the Bot River with respect to the proposed development activities. The points below summarise the considerations undertaken:

- In applying the risk assessment, it was assumed that the mitigation hierarchy as advocated by the DEA *et al.* (2013) was followed, i.e. the impacts would first be avoided, minimised if avoidance is not feasible, rehabilitated as necessary and offset if required;
- Thus, the DWS risk assessment was applied assuming that all listed mitigation measures were implemented, therefore the results of the DWS risk assessment provided in this report presents the perceived impact significance *post-mitigation*;
- It must be noted that at the time of this assessment the proposed development activities had not yet taken place. The risk assessment provided in this report is therefore based on the potential anticipated impacts posed by proposed development activities on the aquatic ecological integrity of the Bot River; and
- The majority of the impacts associated with the proposed development activities are site specific except activities that result in sediment-laden, poor quality runoff that enter could enter into the Bot River and influence its downstream reaches;
- **The potential impacts pertaining to the proposed Dam 2 expansion activities and cultivation extension areas between Dam 1 and Dam 2 were deemed to pose no quantum of risk on any freshwater ecosystems and therefore were not rated in the risk assessment matrix. Only the activities pertaining to the expansion of Dam 1, or the newly proposed dam directly downgradient of Dam 1 and the cultivation areas east of Dam 1 were assessed; and**
- Most impacts are considered easily detectable and mitigation measures thereof are considered to be easily practicable.

7.1 Risk Assessment Discussion

There are four key ecological risks on the assessed freshwater ecosystems that were assessed, namely:

- Loss of freshwater ecosystem habitat and ecological structure resulting in impacts to biota;
- Changes to the socio-cultural and service provision;
- Impacts on the hydrology and sediment balance of the freshwater ecosystems; and
- Impacts on water quality.

The results of the risk assessment are summarised in Table 6 that follows, including key mitigation measures for each activity that must be implemented to reduce the impacts of the proposed development.

According to the DWS Risk Assessment Matrix guidelines, Moderate Risk ranges between 56-80 points can be down adjusted by 25 points to realise a Low Risk provided that additional mitigation measures (highlighted in red) are adhered to. Down adjustment however was not necessary considering that all activities were determined to be of a Low Risk.

The single most effective mitigation measure is to ensure that construction is completed in the summer dry season to avoid the prospects of sediment-laden runoff and potentially poor water quality being flushed from the proposed Dam 1 expansion, or the proposed dam directly downgradient of Dam 1 and vineyard construction areas (Alternative or Preferred development) into the Bot River downgradient. In any event, sand bags must be located downgradient of the proposed vineyard area (for the width of the development) to safeguard the Bot River from additional sources of sedimentation and poor water

quality, especially considering that this river is already choked with sediment and suffers to poor water quality.

Overtopping of the proposed Dam 1 expansion or proposed dam directly downgradient of Dam 1 should be avoided to further limit risks to the downgradient Bot River and an AIP monitoring and clearing programme must be in place to manage the resurgence of AIPs in the areas associated with the proposed development. It must be noted that non-compliance to the suggested mitigation measures would increase the risks of the development activities to a Moderate Risk.

Table 6: Summary results of the DWS Risk Assessment applied to the Bot River for the significance of the Alternative (Alternative 1) – Dam 1 expansion and Preferred (Alternative 2) new dam downgradient of Dam 1 activities and Alternative and Preferred cultivation area activities downstream of Dam 1.

No.	Phases	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Confidence level	Control Measures
1	CONSTRUCTION PHASE	Site preparation prior to construction activities (applicable to the expansion of Dam 1 or proposed dam directly downgradient of Dam 1) and the proposed vineyard areas downgradient).	➢ Vehicular movement (transportation of construction materials and access to the sites)	➢ Transportation of construction materials can result in disturbances to soil, and increased risk of sedimentation to downstream Bot River; ➢ Soil and stormwater contamination from oils and hydrocarbons originating from construction vehicles that may be flushed into the Bot River	1.25	3.25	14	**45.5**	**L**	80	➢ The riparian area of the Bot River which is 35 m downgradient of the lower boundary of the proposed vineyard must be considered a no go area for vehicles and staff and vehicle movement must be limited to existing dirt roads as far as operationally possible; ➢ Contractor laydown areas and material storage facilities to remain 32 m away from the delineated extent of the Bot River and vehicle re-fuelling must take place off site; ➢ Dedicated parking area for construction vehicles must be located away from sensitive areas, and drip trays must be located beneath any leaking equipment and lubricant/fuel absorbing media (moss/peat type products) within drip trays must be used to contain spilled material; ➢ All cleared vegetation must be stockpiled in a designated area, outside of the delineated extent of the Bot River and after clearing, all material must be disposed of at a registered garden refuse site and may not be burned or mulched on site; ➢ Topsoil must be stockpiled separately from all other materials, for use to cover the new dam wall for revegetation. Soil stockpiles may not be contaminated, and it must cover as minimal a surface area as possible, however the stockpiles may not exceed 2 m in height; ➢ All exposed soils must be protected for the duration of the construction phase with a suitable geotextile (e.g. Geotextile or hessian sheeting) to prevent dust generation that could potentially result in vegetation smothering and sedimentation of the Bot River riparian zone and the terrestrial fynbos vegetation surrounding the vineyard. Airborne dust must be reduced at construction sites through: o Damping dust generation areas with freshwater (although not in sufficient quantities to generate runoff); o Use of geotextile or brush barrier fences; and o Covering stockpiles with plastic sheets. ➢ Edge effects of activities including erosion and alien/ weed control need to be strictly managed in these areas.
2			➢ Removal of vegetation and disturbance to soil associated with the proposed dam directly downgradient of Dam 1 and proposed vineyard.	➢ Sediment transported as runoff into the downgradient Bot River; ➢ Exposure of soil, leading to increased runoff, and erosion, and thus increased sedimentation of the Bot River; ➢ Proliferation of alien vegetation as a result of disturbances.	1.25	3.25	15	**48.75**	**L**	80	
3		Construction activities applicable to the expansion of Dam 1 or proposed dam directly downgradient of Dam 1 and proposed vineyards downgradient.	➢ Excavation of dam basin to source fill material; ➢ Stockpiling of material; ➢ Infilling and compaction of the proposed dam wall footprint.	➢ Runoff from stockpiled material or sediment laden runoff from the dam construction footprint and cleared vineyard areas could enter the downstream Bot River and increase its sediment load.	1.5	3.5	15	**52.5**	**L**	80	➢ It is imperative that all construction works be undertaken during the dry, summer months when sedimentation and pollutants are unlikely to be mobilised by surface runoff, avoiding impacts to the Bot River downgradient; ➢ It is assumed that material required for the dam wall expansion will be excavated from the dam basin or the surrounding terrestrial habitat. Material quarries should be inert and unable to leach toxicants to the receiving environment prior to commencement of works; ➢ It is assumed that the dam walls will be earth and no hard infrastructure (such as gabion baskets will be required); ➢ The material excavated from the dam basin intended for use in the construction of the dam wall must be stockpiled in the area associated with the dam's proposed new inundated full supply level footprint (west of the dam wall). This will limit the sedimentation

No.	Phases	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Confidence level	Control Measures
											of the downgradient Bot River. These stockpiles may not exceed 2 m in height and must be covered with a suitable geotextile if the stockpiles will be on site for longer than 30 days; ➢ All materials used to construct the dam wall should not generate toxic leachates or lead to significant changes in pH or dissolved salt concentrations; especially considering that outflow of the dam drains to the Bot River; ➢ No plastic lining may be used as part of the dam construction as this has various ecological impacts, with special mention of impacts to faunal assemblages; ➢ Rocks must be placed at any outlet pipes (downgradient of the dam wall) to be installed within the dam wall and indigenous vegetation established to bind the soil of the bed and to prevent erosion. This will also promote diffuse flow and decrease the velocity of water released downgradient towards the Bot River, assuming that this dam will still occasionally release overflows to the Bot River after the vineyard has been developed; ➢ It is recommended that any proposed spillways be lined at the base with energy dissipating structures (such as Armorflex) to reduce the velocity of water inflow into the downgradient areas and prevent erosion thereof during high flow events; ➢ The slope between the (if one is proposed - detailed designs were not available at the time this report was compiled) spillway and the bottom of the dam wall must be gradual, to prevent a drop forming at the edge of the spillway which will result in incision and embankment erosion; ➢ The release of water into the dam should be done in such a way that water does not drop from a significant height into the dam as this will cause erosion, gully formation and turbid water within the dam; and ➢ The dam walls must be revegetated after the construction activities, to stabilize the soils; ➢ Sediment traps must be installed downgradient of the proposed vineyard for its full length to prevent any excess sediments arising from the construction works being transported into the Bot River and must be regularly cleared by hand. <u>Should concrete be required:</u> No mixed concrete may be deposited outside of the designated construction footprint. The following mitigation measures must be adhered to: ➢ Fresh concrete and cement mortar must preferably be mixed in the laydown area/construction camp associated with the proposed dam 1 expansion area, may not be mixed on bare soil, and must be contained within a lined, bound or bunded portable mixer. Consideration must be given to the use of ready mix concrete; ➢ A batter board or other suitable platform/mixing tray is to be provided onto which any mixed concrete can be deposited whilst it awaits placing; ➢ A washout area must be designated in area that will not be subjected to runoff downgradient and wash water must be treated on-site or discharged to a suitable

No.	Phases	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Confidence level	Control Measures
											sanitation system; wash water is not permitted to be discharge into freshwater ecosystems; ➢ Empty cement bags must be disposed of through the hazardous substance waste stream; ➢ Concrete spillage outside of the demarcated area must be promptly removed and taken to a suitably licensed waste disposal site.
4		Rehabilitation requirements surrounding Dam 1 or the proposed dam downgradient of Dam 1 and associated vineyards downgradient.	Post construction rehabilitation to maintain ecological condition	➢ AIP proliferation. ➢ New erosion and incision due to the expanded dam walls ➢ Litter and waste removal.	1.5	5.5	10	**55**	**L**	80	➢ An alien vegetation monitoring programme should be developed to monitor any further growth of potential alien vegetation surrounding the dam and cleared vineyard area (with specific mention of *Eucalyptus* spp, *Acacia mearnsii,* and *Pinus pinaster* to name a few). This will need to be monitored until all natural vegetation has re-established surrounding the dam and vineyard area; ➢ Any erosion or incision observed as a result of the newly expanded dam wall should be addressed using the following methods to prevent sedimentation of the dams to retain their maximum supply level: o **Re-sloping** – side walls of the dam should be re-sloped to a 3:1 ratio in order to prevent further gully formation during the operation of the dams. o **Brush layering** is when branches are placed perpendicular to the slope contour. This method is effective for earth reinforcement and mass stability. Brush layers break up the slope length, preventing surface erosion, and reinforce the soil with branch stems and roots, providing resistance to sliding or shear displacement. Brush layers also trap debris, aid infiltration on dry slopes, dry excessively wet sites, and mitigate slope seepage by acting as horizontal drains. Brush layers facilitate vegetation establishment by providing a stable slope and a favourable microclimate for growth of vegetation (USEPA, 2005). o **Live gully repair** is a technique that is similar to branch packing but is used to repair rills and gullies. Live gully repairs offer immediate reinforcement and reduce the velocity of concentrated flows. They also provide a filter barrier that reduces further rill and gully erosion and must be used where gully erosion is taking place on the project footprint(USEPA, 2005; and ➢ All dam walls must be revegetated after the construction activities to stabilize soil and prevent erosion of the dam wall. A graminoid seed mixture can be used for this purpose, as it will allow for quick establishment.

No.	Phases	Activity	Aspect	Impact	Severity	Consequence	Likelihood	Significance	Risk Rating	Confidence level	Control Measures
5	OPERATIONAL PHASE	Operation of expanded Dam 1 or the proposed dam directly downgradient of Dam 1 and associated vineyards downgradient.	Overflow of the dam once full capacity has been reached.	➢ Terrestrial vegetation encroachment downstream of the dam; ➢ Potential overtopping of the dam and the flushing of sediment laden runoff into the downgradient Bot River.	1.5	6.5	8	52	L	80	*This impact was considered only low as the dams are already existing and repairs to the dam will reduce impacts of excess sediment in the downstream areas. ➢ The dams, spillways, and any outlet pipes should regularly be inspected for erosion, especially after heavy rainfall events when overflow from the dams is expected and the flow velocity is increased. If erosion is noted, this should be rectified, preferably through the reinstatement of vegetation in the eroded areas. If erosion is pronounced, erosion control devices such as reno mattresses should be considered, in consultation with a freshwater specialist; ➢ AIPs must be managed, and annual removal/chemical treatment must be undertaken. An AIP control plan must be developed for the freshwater ecosystems within the proposed development area for at least 3 years post construction, thereafter refocusing on problem alien reestablishment areas; ➢ A small drainage furrow should be constructed downgradient of the vineyard, but at least 32 m outside of the delineated extent of the Bot River to capture surface runoff during irrigation. This will prevent potentially sediment laden surface water from smothering the riparian zone of the Bot River.
6			Routine maintenance (including desilting activities) leading to increased vehicle access.	➢ Soil compaction and disturbance around the dam; ➢ Staff operation of the vineyard; ➢ Potential sedimentation of downstream Bot River; ➢ Vegetation degradation and alien invasive proliferation.	1.5	3.5	12	42	L	80	➢ Only existing roadways should be utilised during maintenance and monitoring activities to avoid indiscriminate movement of vehicles; ➢ The dam will need to be desilted intermittently to ensure the storage capacity is maintained. During desilting, all silt within the dam basins should immediately be removed from site to prevent sedimentation of the Bot River downgradient during outflow events; ➢ Additionally, during desilting a temporary silt trap should be installed at the spillway. This should be emptied on a regular basis during the desilting process to prevent any excess silt being washed down into the Bot River; and ➢ Should repair be required to address seepage, mitigations as per construction activities above are applicable depending upon the location and severity of the seepage/structure failure.

The activities associated with the construction phase of the dam directly downgradient of Dam 1 and the Alternative and Preferred cultivation areas, and the operation phase (overflow of the proposed dam directly downgradient of Dam 1 and future maintenance of this dam) overall pose a low risk to the integrity of the Bot River. Should mitigation measures not be adhered to, the risk significance will likely be moderate.

Assuming that strict enforcement of cogent, well-developed mitigation measures takes place in concert with rehabilitation, erosion control and long-term management of alien and invasive species, the significance of impacts arising from the proposed development will be adequately managed and the overall PES of the Bot River will not be significantly impacted on.

7.2 Cumulative Impacts

It is considered important to note the latent and cumulative impacts listed below:

- Hydrological:
  - Cumulative impact on the instream flows of the Bot River resulting in losses of hydraulic biotopes utilised by aquatic macro-invertebrates and fish;
  - Changes to the pattern flow and timing of water in the landscape.
- Geomorphological:
  - Disturbance of the sediment balance by the trapping of sediment in the upper reaches that is meant to naturally replenish downstream ecosystems; and
  - Ongoing erosion and sedimentation;
- Water Quality
  - Potential changes in water quality due to sediment laden runoff into the Bot River from either dam outflows or the proposed vineyard area;
- Biota
  - Potential loss of species diversity and abundance

The overall integrity of the Bot River is already severely compromised in terms of:

- Increased evaporation of water falling on bare or loosely vegetated ground due to catchment hardening from agriculture;
- Increased water retention within in and off channel impoundments and river abstraction;
- Associated shifts in the pattern, flow/flood peaks and timing of water in the Bot River; and
- Numerous river crossings, bank straightening and modification and alien vegetation, the proposed development activities will not add to these existing cumulative impacts.

It is therefore unlikely that the proposed development would pose additional cumulative impacts to the Bot River, over and above the acting upstream impacts, especially if performed in the dry season when sediment-laden surface runoff is manageable, if required at all.

8 CONCLUSION

FEN Consulting (Pty) Ltd was appointed to conduct a specialist aquatic and freshwater assessment as part of the EA and WUA processes for the proposed Alternative and Preferred developments involving the expansion of dam/s and the construction of a new dam directly downgradient of Dam 1 to enable the irrigation, and thereby, extention of cultivation areas on portion 3 of farm 781, Bot River, Overstrand Municipality, Western Cape.

The Alternative development comprises the expansion of Erin de Vigne dam (hereafter, "Dam 1) from 6000 m^3 to 35 000 m^3 and the development of a ~ 7 ha cultivation area largely to the east of the dam, while the Preferred development comprises the development of a new 2000 m^3 dam directly below Dam 1, the expansion of Dam 2 from 25 000 m^3 to 67 000 m^3 and the development of cultivation areas between these dams and east of Dam 1, altogether comprising ~ 10 ha.

The proposed dam directly downgradient of Dam 1 overlies an area in which a persistent linear freshwater feature was observed which was field verified to be an artificial drainage line.

No freshwater ecosystems were found in the immediate vicinity of the Alternative and Preferred developments and thus do not pose any fatal flaws from a construction perspective. From an operational perspective, the overflow of Dam 2 would dissipate into an alien tree dominated terrestrial area and is also deemed acceptable. Similarly, the areas proposed for vineyard cultivation are largely alien infested areas and also pose no restrictions to the development of the proposed vineyards.

The overflow of the newly proposed dam directly downgradient of Dam 1 could however elicit an impact on the Bot River which is approximately 220 m and 35 m downgradient respectively, which warrants an aquatic assessment to determine its ecological condition and the risk significance of development activities potentially impacting on this river.

The field assessment took place in November during the Western Cape late Spring season when the Bot River was flowing. The results of the aquatic assessments are summarised below in Table 7.

Table 7: Summary of the results of the aquatic ecological assessments.

Aquatic Assessment	Result
IHI– Instream	Category D (Largely Modified)
(IHI) – Riparian	Caregory E (Seriously Modified)
VEGRAI	Category D/E (Largely to Seriously Modified)
MIRAI	Category C (Moderately Modified)
SASS5	Category B(Largely Natural)
IHAS	57 % (Fair)
EIS	High
SPI	Moderate quality (Class C) and mesotrophic

The application of the DWS GN509 Risk Assessment Matrix, as it relates to the NWA, determined that all activities pertaining to the Alternative and Preferred development pose a low risk significance of impact to the Bot River. This is on condition that pertinent mitigation measures such as construction in the dry season, staff and vehicles remaining outside of the delineated extent of the Bot River, sediment traps and an Alien and Invasive Plant (AIP) management plan being in place, else the risk significances for certain activities may be increased to a Moderate Risk.

In terms of the EA, the proposed Alternative and Preferred developments fall outside of the 32 m NEMA ZoR which warrants exception of the need to apply for EA with DEA&DP in terms of Activity 12 and 19 of Listing Notice 1 of GN327 and Activity 14 of Listing Notice 3 of GN324. In terms of WUA, a portion of the proposed cultivation area under both the Alternative and Preferred development falls within the 100 m GN509 ZoR of the Bot River and the entirety of both the proposed Alternative and Preferred developments falls within the 500 m GN509 ZoR of an unchanneled valley bottom wetland, all requiring WUA authorisation with the DWS.

Assuming that strict enforcement of cogent, well-developed mitigation measures takes place, the significance of impacts arising from the proposed development activities will be adequately managed and the overall PES of the Bot River will not be significantly impacted on. It is therefore the opinion of

the freshwater specialist that the proposed development activities be considered favourably provided that all mitigation measures in this report are implemented.

The No-Go alternative considers the option of 'do nothing' and maintaining the status quo, which would lead to the loss of vineyard production, job creation and economic growth in the region, that ultimately must be weighed up against the current ecological and economic value of the degraded proposed Alternative and Preferred development areas.

9 REFERENCES

Chutter, F. M. (1998). *Research on the rapid biological assessment of water quality impacts in streams and rivers.* Report to the water research commission by Environmentek, CSIR, WRC report No 422/1/98. Pretoria: Government printer.

Dallas, H.F. (2007). *River Health Programme: South African Scoring System (SASS) data interpretation guidelines.* The Freshwater Consulting Group / Freshwater Research Unit, University of Cape Town

Department of Water Affairs and Forestry (DWAF). (1996). *South African water quality guidelines vol. 7, Aquatic ecosystems*.

Department of Water Affairs and Forestry (DWAF). (1999). *Resource Directed Measures for Protection of Water Resources. Volume 3: River Ecosystems Version 1.0.* Resource Directed Measures for Protection of Water Resources, Pretoria, South Africa.

Department of Water Affairs and Forestry (DWAF). 2008. Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas, prepared by M. Rountree, A. L. Batchelor, J. MacKenzie and D. Hoare. Report no. X. Stream Flow Reduction Activities, Department of Water Affairs and Forestry, Pretoria, South Africa.

Department of Water and Sanitation (DWS). (2014). *A Desktop Assessment of the Present Ecological State, Ecological Importance and Ecological Sensitivity per Sub Quaternary Reaches for Secondary Catchments in South Africa.* Secondary: C2 Compiled by RQIS-RDM: Online available: https://www.dwa.gov.za/iwqs/rhp/eco/peseismodel.aspx as retrieved in November 2016

Department of Water and Sanitation (DWS). (2019). National Water Act (Act no. 36 of 1998). Proposed Classes of Water Resources and Resource Quality Objectives for the Berg Catchment. Government Gazette No. 42451. May 2019.

Dickens, C. & Graham, M. (2002). *The South African Scoring System (SASS) Version 5. Rapid Bioassessment Method for Rivers.* African Journal of Aquatic Science 27: 1-10.

DJ Hahen and Associates. (2022). Project No. DJH239: Expansion of Erin De Vigne Dam 1 Portion 3 of Farm 781, Botrivier.

Gerber, A. and Gabriel, M.J.M. (2002). *Aquatic Invertebrates of South African Rivers. First Edition.* Department of Water Affairs: Pretoria, South Africa.

Kleynhans C.J., Thirion C., Moolman J, Gaulana L. (2007a). *A Level II River Ecoregion Classification System for South Africa, Lesotho and Swaziland.* Report No. N/0000/00/REQ0104. Resource Quality Services, Department of Water Affairs and Forestry, Pretoria.

Kleynhans CJ, Louw MD, Moolman J. (2007c). *Reference frequency of occurrence of fish species in South Africa.* Report produced for the Department of Water Affairs and Forestry (Resource Quality Services) and the Water Research Commission.

Kleynhans CJ, MacKenzie J, Louw MD. (2007b). *Module F: Riparian Vegetation Response Assessment Index in River EcoClassification: Manual for EcoStatus Determination (version 2).* Joint Water Research Commission and Department of Water Affairs and Forestry report. WRC Report No. TT 333/08.

Kleynhans CJ. (2007). *Module D: Fish Response Assessment Index in River EcoClassification: Manual for EcoStatus Determination (version 2)*. Joint Water Research Commission and Department of Water Affairs and Forestry report. WRC Report No. TT330/08.

Kleynhans, C.J., Louw, M.D., Graham, M. (2008). Module G: EcoClassification and EcoStatus determination in River EcoClassification: Index of Habitat Integrity (Section 1, Technical manual). Joint Water Research Commission and Department of Water Affairs and Forestry report. WRC Report No. TT 377-08.

McMillan, P.H. (1998). *An integrated habitat assessment system (IHAS v2) for the rapid biological assessment of rivers and streams.* A CSIR research project. Number ENV-P-I 98132 for the water resources management programme. CSIR. ii +44 pp/

National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA).

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

National Water Act, 1998 (Act No. 36 of 1998) (NWA). Section 21(c) and (i).

NFEPA: Driver, A., Nel, J.L., Snaddon, K., Murruy, K., Roux, D.J., Hill, L., Swartz, E.R., Manuel, J. and Funke, N. 2011. Implementation Manual for Freshwater Ecosystem Priority Areas. Water Research Commission. Report No. 1801/1/11. Online available: http://bgis.sanbi.org/nfepa/project.asp

Ollis, D.J., Boucher, C., Dallas, H.F. and Esler, K. (2006). *Preliminary testing of the integrated habitat assessment system (IHAS) for aquatic macroinvertebrates.* Southern Africa Journal of Aquatic Science 31 (1) 1-14.

Thirion C. (2007). *Module E: Macro-Invertebrate response assessment index (MIRAI). In: River ecoclassification manual for ecostatus determination (Version 2).* Joint Water Research Commission and Department of Water Affairs and Forestry report.

APPENDIX A – Terms of Use and Indemnity

The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information. The report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken and FEN Consulting (Pty) Ltd and its staff reserve the right to, at their sole discretion, modify aspects of the report including the recommendations if and when new information may become available from ongoing research or further work in this field, or pertaining to this investigation.

Although FEN Consulting (Pty) Ltd exercises due care and diligence in rendering services and preparing documents, FEN Consulting (Pty) Ltd accepts no liability and the client, by receiving this document, indemnifies FEN Consulting (Pty) Ltd and its directors, managers, agents and employees against all actions, claims, demands, losses, liabilities, costs, damages and expenses arising from or in connection with services rendered, directly or indirectly by FEN Consulting (Pty) Ltd and by the use of the information contained in this document.

This report must not be altered or added to or used for any other purpose other than that for which it was produced without the prior written consent of the author(s). This also refers to electronic copies of this report which are supplied for the purposes of inclusion as part of other reports, including main reports. Similarly, any recommendations, statements or conclusions drawn from or based on this report must make reference to this report. If these form part of a main report relating to this investigation or report, this report must be included in its entirety as an appendix or separate section to the main report.

APPENDIX B – Legislative Requirements

The Constitution of the Republic of South Africa, 1996	The environment and the health and well-being of people are safeguarded under the Constitution of the Republic of South Africa, 1996 by way of section 24. Section 24(a) guarantees a right to an environment that is not harmful to human health or well-being and to environmental protection for the benefit of present and future generations. Section 24(b) directs the state to take reasonable legislative and other measures to prevent pollution, promote conservation, and secure the ecologically sustainable development and use of natural resources (including water and mineral resources) while promoting justifiable economic and social development. Section 27 guarantees every person the right of access to sufficient water, and the state is obliged to take reasonable legislative and other measures within its available resources to achieve the progressive normalization of this right. Section 27 is defined as a socio-economic right and not an environmental right. However, read with section 24 it requires of the state to ensure that water is conserved and protected and that sufficient access to the resource is provided. Water regulation in South Africa places a great emphasis on protecting the resource and on providing access to water for everyone.
National Environmental Management Act, 1998 (Act No. 107 of 1998)	The National Environmental Management Act, 1998 (Act No. 107 of 1998) and the associated Regulations as amended in 2017, states that prior to any development taking place within a wetland or riparian area, an environmental authorisation process needs to be followed. This could follow either the Basic Assessment Report (BAR) process or the Environmental Impact Assessment (EIA) process depending on the scale of the impact. Provincial regulations must also be considered.
National Water Act , 1998 (Act No. 36 of 1998)	The National Water Act, 1998 (Act No. 36 of 1998) recognises that the entire ecosystem and not just the water itself in any given water resource constitutes the resource and as such needs to be conserved. No activity may therefore take place within a watercourse unless it is authorised by the Department of Water and Sanitation (DWS). Any area within a wetland or riparian zone is therefore excluded from development unless authorisation is obtained from the DWS in terms of Section 21 (c) & (i). A watercourse is defined as: a) A river or spring; b) A natural channel in which water flows regularly or intermittently; c) A wetland, lake or dam into which, or from which water flows; and d) Any collection of water which the minister may, by notice in the Gazette, declare a watercourse.
Government Notice 509 as published in the Government Gazette 40229 of 2016 as it relates to the National Water Act , 1998 (Act No. 36 of 1998)	In accordance with Government Notice (GN)509 of 2016, a regulated area of a watercourse for section 21c and 21i of the NWA, 1998 is defined as: a) The outer edge of the 1 in 100 year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam; b) In the absence of a determined 1 in 100 year flood line or riparian area the area within 100 m from the edge of a watercourse where the edge of the watercourse is the first identifiable annual bank fill flood bench; or c) A 500 m radius from the delineated boundary (extent) of any wetland or pan. This notice **replaces GN1199** and may be exercised as follows: i) Exercise the water use activities in terms of Section 21(c) and (i) of the Act as set out in the table below, subject to the conditions of this authorisation; ii) Use water in terms of section 21(c) or (i) of the Act if it has a low risk class as determines through the Risk Matrix; iii) Do maintenance with their existing lawful water use in terms of section 21(c) or (i) of the Act that has a LOW risk class as determined through the Risk Matrix; iv) Conduct river and storm water management activities as contained in a river management plan; v) Conduct rehabilitation of wetlands or rivers where such rehabilitation activities have a LOW risk class as determined through the Risk Matrix; and vi) Conduct emergency work arising from an emergency situation or incident associated with the persons' existing lawful water use, provided that all work is executed and reported in the manner prescribed in the Emergency protocol. A General Authorisation (GA) issued as per this notice will require the proponent to adhere with specific conditions, rehabilitation criteria and monitoring and reporting programme. Furthermore, the water user must ensure that there is a sufficient budget to complete, rehabilitate and maintain the water use as set out in this GA. Upon completion of the registration, the responsible authority will provide a certificate of registration to the water user within 30 working days of the submission. On written receipt of a registration certificate from the Department, the person will be regarded as a registered water user and can commence within the water use as contemplated in the GA.

APPENDIX C – Method of Assessment

The sections below describe the methodology used to assess the aquatic ecological integrity based on water quality, instream and riparian habitat condition and biological impacts and integrity.

Visual Assessment

Each site was investigated in order to identify visible impacts on the site, with specific reference to impacts from surrounding activities. Both natural constraints placed on ecosystem structure and function, as well as anthropogenic alterations to the system, were identified by observing conditions and relating them to professional experience. Photographs of each site were taken to provide visual indications of the conditions at the time of assessment. Factors which were noted in the site-specific visual assessments included the following:

- Stream morphology;
- Instream and riparian habitat diversity;
- Stream continuity;
- Erosion potential;
- Depth flow and substrate characteristics;
- Signs of physical disturbance of the area; and
- Other life forms reliant on or associated with aquatic ecosystems.

Physico Chemical Water Quality Data

On-site testing of biota specific water quality parameters including pH, Electrical Conductivity (EC), dissolved oxygen concentration (DO) and temperature. The results aid in the interpretation of the data obtained by the biomonitoring. Results are discussed against the guideline water quality values for aquatic ecosystems (DWAF 1996 vol. 7) and the Berg River RWQO (DWS, 2019).

General Habitat Integrity

The general habitat integrity of each site was discussed based on the application of the Index of Habitat Integrity (Kleynhans *et al.* 2008). It is important to assess the habitat at each site in order to aid in the interpretation of the results of the community integrity assessments, by taking habitat conditions and impacts into consideration. This method describes the Present Ecological State (PES) of both the in-stream and riparian habitat at each site. The method classifies habitat integrity into one of six classes, ranging from unmodified/natural (Class A) to critically modified (Class F), as indicated in Table C1 below.

Table C1: Classification of Present State Classes in terms of Habitat Integrity [Kleynhans *et al.* 2008]

Class	Description	Score (% of total)
A	Unmodified, natural.	90 - 100
B	Largely natural with few modifications. The flow regime has been only slightly modified and pollution is limited to sediment. A small change in natural habitats may have taken place. However, the ecosystem functions are essentially unchanged.	80 - 89
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60 - 79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40 – 59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20 – 39
F	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	0 - 19

The Riparian Vegetation Response Assessment Index (VEGRAI)

VEGRAI is designed for qualitative assessment of the response of riparian vegetation to impacts in such a way that qualitative ratings translate into quantitative and defensible results (Kleynhans *et al*., 2007b). Results are defensible because their generation can be traced through an outlined process (a suite of rules that convert assessor estimates into ratings and convert multiple ratings into an Ecological Category).

Riparian vegetation is described in the National Water Act (NWA; Act 36 of 1998) as follows: 'riparian habitat' includes the physical structure and associated vegetation of the areas associated with a freshwater ecosystem 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 land areas.

Table C2: Descriptions of the A-F ecological categories.

Ecological category	Description	Score (% of total)
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitat and biota may have taken place but the ecosystem functions are essentially unchanged.	80-89
C	Moderately modified. Loss and change of natural habitat have occurred, but the basic ecosystem functions are still predominately unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Critically modified. Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota. In the worst instances, the basic ecosystem functions have been destroyed and the changes are irreversible	0-19

Habitat for aquatic macro-invertebrates
The Integrated Habitat Assessment System (IHAS) was applied according to the protocol of McMillan (1998). This index was used to determine specific habitat suitability for aquatic macro-invertebrates as well as to aid in the interpretation of the results of the South African Scoring System version 5 (SASS5) scores. However, according to a study conducted within the Mpumalanga and Western Cape regions, the IHAS method does not produce reliable scores with regard to the suitability of habitat at sampling sites for aquatic macroinvertebrates (Ollis *et al*., 2006). Furthermore, the performance of the IHAS seems to vary between geomorphologic zones and between biotope groups (Ollis *et al*., 2006). It has, however; become clear that IHAS requires further validation and testing, although the basic data remains of value (Thirion, 2007).

Table C3: IHAS Scores and their corresponding description of overall condition (quality and quantity) of available aquatic macroinvertebrate habitat (McMillan, 1998)

IHAS Score (%)	Description
>75	Excellent
65 – 74	Good
55 – 64	Adequate / Fair
<55	Poor

Aquatic Macro-Invertebrates: South African Scoring System version 5 (SASS5)
Aquatic Macro-invertebrates were sampled using the qualitative kick sampling method called SASS5 (South African Scoring System version 5) (Dickens and Graham, 2002). The SASS5 method has been specifically designed to comply with international accreditation protocols. This method is based on the British Biological Monitoring Working Party (BMWP) method and has been adapted for South African conditions by Dr. F. M. Chutter (1998). The assessment was undertaken according to the protocol, as defined by Dickens & Graham (2002). All work was undertaken by an accredited SASS5 practitioner.

The SASS5 method was designed to incorporate all available biotypes at a given site and to provide an indication of the integrity of the of the aquatic macro-invertebrate community through recording the presence of various macro-invertebrate families at each site, as well as consideration of abundance of various populations, community diversity and community sensitivity. Each taxon is allocated a score according to its level of tolerance to river health degradation (Dallas 2007).

This method relies on churning up the substrate with your feet and sweeping a finely meshed SASS net, with a pore size of 1000 micron mounted on a 300 mm square frame, over the churned-up area

several times. In stony bottomed flowing water biotopes (rapids, riffles, runs, etc.) the net downstream of the assessor and the area immediately upstream of the net is disturbed by kicking the stones over and against each other to dislodge benthic invertebrates. The net was also swept under the edge of marginal and aquatic vegetation to cover from 1-2 meters. Identification of the organisms was made to family level (Thirion *et al*., 1995; Dickens & Graham, 2002; Gerber & Gabriel, 2002).

Interpretation of the results of biological monitoring depends, to a certain extent, on interpretation of site-specific conditions (Thirion *et.al*, 1995). In the context of this investigation it would be best not to use SASS5 scores in isolation, but rather in comparison with relevant habitat scores. The reason for this is that some sites have a less desirable habitat or fewer biotopes than others do. In other words, a low SASS5 score is not necessarily regarded as poor in conjunction with a low habitat score. Also, a high SASS5 score, in conjunction with a low habitat score, can be regarded as better than a high SASS5 score in conjunction with a high habitat score. A low SASS5 score, together with a high habitat score, would be indicative of poor conditions. The IHAS Index is valuable in helping to interpret SASS5 scores and the effects of habitat variation on aquatic macro-invertebrate community integrity.

Classification of the system took place by comparing the present community status to reference conditions, which reflect the best conditions that can be expected in rivers and streams within a specific area, and also reflect natural variation over time.

Aquatic Macro-Invertebrates: Macro-invertebrate Response Assessment Index (MIRAI)
The four major components of a stream system that determine productivity, with particular reference to aquatic organisms, are flow regime, physical habitat structure, water quality and energy inputs. An interplay between these factors (particularly habitat and availability of food sources) result in the discontinuous, patchy distribution pattern of aquatic macro-invertebrate populations. As such aquatic invertebrates shall respond to habitat changes (i.e. changes in driver conditions).

To relate drivers to such changes in habitat and aquatic invertebrate condition, two key elements are required. Firstly, habitat preferences and requirements for each taxa present should be obtained. As such reference conditions can be established against which any response to drivers can be measured. Secondly, habitat features should be evaluated in terms of suitability and the requirements mentioned in the first point. As a result, expected and actual patterns can be evaluated to achieve an Ecostatus Category rating.

Based on the three key requirements, the MIRAI provides an approach to deriving and interpreting aquatic invertebrate response to driver changes. The index has been applied to the sites following methodology described by Thirion (2007). Aquatic macro-invertebrates expected at each point were derived both from the Department of Water and Sanitation (DWS) Resource Quality Information Services (RQIS) PES/EIS database, as well as habitat, flow and water parameters (Thirion, 2007).

Ecological Importance and Sensitivity (EIS) Method of assessment

The EIS method considers a number of biotic and habitat determinants surmised to indicate either importance or sensitivity. The determinants are rated according to a four-point scale (Table C7). The median of the resultant score is calculated to derive the EIS category (Table C8).

Table C4: Definition of the four-point scale used to assess biotic and habitat determinants presumed to indicate either importance or sensitivity

Four point scale	Definition
1	One species/taxon judged as rare or endangered at a local scale.
2	More than one species/taxon judged to be rare or endangered on a local scale.
3	One or more species/taxon judged to be rare or endangered on a Provincial/regional scale.
4	One or more species/taxon judged as rare or endangered on a National scale (i.e. SA Red Data Books)

Table C5: Ecological importance and sensitivity categories (DWAF, 1999)

EISC	General Description	Range of median
Very high	Quaternaries/delineations that are considered to be unique on a national and international level based on unique biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are usually very sensitive to flow modifications and have no or only a small capacity for use.	>3-4
High	Quaternaries/delineations that are considered to be unique on a national scale based on their biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) may be sensitive to flow modifications but in some cases may have substantial capacity for use.	>2-≤3
Moderate	Quaternaries/delineations that are considered to be unique on a provincial or local scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are not usually very sensitive to flow modifications and often have substantial capacity for use.	>1-≤2
Low/ marginal	Quaternaries/delineations that are not unique on any scale. These rivers (in terms of biota and habitat) are generally not very sensitive to flow modifications and usually have substantial capacity for use.	≤1

Diatom Community Analysis

Diatom slides were prepared through use of the hot Hydrochloric Acid (HCl) and Potassium Permanganate ($KMnO_4$) method as this is the preferred method of use for South African samples, as it usually contains higher levels of organic content (Taylor *et al.,* 2007). The clean samples were mounted onto microscope slides using pleurax as it has a high refraction index (1.73) ideal for diatom frustule identification. Diatom taxa were identified to the lowest possible level of identification and diatom valves counted (400 counts) for ecological conclusions to be drawn. Dominant species ecology was inferred from Taylor *et al*. (2007) and Omnidia software (Lecointe *et al.,* 1993) were used to calculate diatom index scores with score interpretation presented in Tables 1 to 4. The following indices were calculated for the present report:

- Specific Pollution sensitivity Index (SPI) (CEMAGREF, 1982) (Tables 1 & 2): This index is the most comprehensive as it includes >1400 species to calculate its final score and provides a measure of organic pollution.
- Generic Diatom Index (GDI) (Coste and Ayphassorho, 1991) (Table 2): Final score is based on genus level and is a measure of organic pollution.
- Trophic Diatom Index (TDI) (Kelly and Whitton, 1995) (Table 3): The index's final score is quantified based on the degree of organic and inorganic pollution.
- Percentage Pollution Tolerant Valves (%PTV) (Kelly and Whitton, 1995) (Table 4): Indicates the diatoms in the sampled community that are tolerant to pollution, thus indicating the degree of eutrophication vs organic pollution. The %PTV score indicates whether nutrients or organic pollution contributed to the TDI final score.

Values for the SPI and GDI were transformed to a score out of 20 where a score of 0 indicates eutrophication and very heavy pollution and a score of 20 indicates no pollution and oligotrophic conditions (Tables 1 & 2). The TDI score is worked off a maximum of 100, where a score of <20% infers that the site is oligotrophic and free from pollution and a score >60% infers that the site is eutrophic with pollution present (Table 3). The %PTV is worked off a maximum score of 100%, where a score of <20% infers that the site is free from organic pollution and a score >60% infers that the site is heavily contaminated with organic pollution (Table 4). For the diatom frustule abnormality assessment, if the percentage of deformed frustules is greater than 2% of the population it is considered that there is significant impact from either pesticides or metals and further assessment is recommended, especially where mining is a related concern.

Table C6: Interpretation of Ecological Categories from the SPI index scores.

Index Score (up to 20)	Ecosystem quality	Ecological Category
18 – 20	High quality	A
17 – 18		A/B
15 – 17	Good quality	B
14 – 15		B/C
12 – 14	Moderate quality	C
10 – 12		C/D
8 – 10	Poor quality	D
6 – 8		D/E
5 – 6	Bad quality	E
4 – 5		E/F
< 4		F

Table C7: Interpretation of both the SPI and GDI scores to determine the Ecosystem Quality and Trophic level of the sampled site.

Index Score (up to 20)	Trophic Level
>17	Oligotrophic (No Pollution)
15 - 17	Oligo-mesotrophic
12 - 15	Mesotrophic
9 - 12	Meso-eutrophic
< 9	Eutrophic

Table C8: Interpretation of the TDI score to determine the Trophic level of the sampled site.

Index Score	Trophic Level
0 – 20	Oligotrophic (No Pollution)
21 – 40	Oligo-mesotrophic
41 – 60	Mesotrophic
61 – 80	Meso-eutrophic
>80	Eutrophic

Table C9: Interpretation of the %PTV score to determine the Ecological Status of the site.

Index Score (up to 20)	Ecological Status
< 20	Site free from organic pollution
21 – 40	Some evidence of organic pollution
41 – 60	Organic pollution likely to contribute to eutrophication
>60	Heavily contaminated with organic pollution

APPENDIX D – Risk Assessment Methodology

In order for the EAP to allow for sufficient consideration of all environmental impacts, impacts were assessed using a common, defensible method of assessing significance that will enable comparisons to be made between risks/impacts and will enable authorities, stakeholders and the client to understand the process and rationale upon which risks/impacts have been assessed. The method to be used for assessing risks/impacts is outlined in the sections below.

The first stage of the risk/impact assessment is the identification of environmental activities, aspects and impacts. This is supported by the identification of receptors and resources, which allows for an understanding of the impact pathway and an assessment of the sensitivity to change. The definitions used in the impact assessment are presented below.

- An **activity** is a distinct process or task undertaken by an organisation for which a responsibility can be assigned. Activities also include facilities or infrastructure that is possessed by an organisation;
- An **environmental aspect** is an 'element of an organizations activities, products and services which can interact with the environment'[3]. The interaction of an aspect with the environment may result in an impact;
- **Environmental risks/impacts** are the consequences of these aspects on environmental resources or receptors of particular value or sensitivity, for example, disturbance due to noise and health effects due to poorer air quality. In the case where the impact is on human health or wellbeing, this should be stated. Similarly, where the receptor is not anthropogenic, then it should, where possible, be stipulated what the receptor is;
- **Receptors** can comprise, but are not limited to, people or human-made systems, such as local residents, communities and social infrastructure, as well as components of the biophysical environment such as wetlands, flora and riverine systems;
- **Resources** include components of the biophysical environment;
- **Frequency of activity** refers to how often the proposed activity will take place;
- **Frequency of impact** refers to the frequency with which a stressor (aspect) will impact on the receptor;
- **Severity** refers to the degree of change to the receptor status in terms of the reversibility of the impact; sensitivity of receptor to stressor; duration of impact (increasing or decreasing with time); controversy potential and precedent setting; threat to environmental and health standards;
- **Spatial extent** refers to the geographical scale of the impact; and
- **Duration** refers to the length of time over which the stressor will cause a change in the resource or receptor.

The significance of the impact is then assessed by rating each variable numerically according to the defined criteria (refer to the table below). The purpose of the rating is to develop a clear understanding of influences and processes associated with each impact. The severity, spatial scope and duration of the impact together comprise the consequence of the impact and when summed can obtain a maximum value of 15. The frequency of the activity, impact, legal issues and the detection of the impact together comprise the likelihood of the impact occurring and can obtain a maximum value of 20. The values for likelihood and consequence of the impact are then read off a significance rating matrix and are used to determine whether mitigation is necessary[4].

The model outcome of the impacts was then assessed in terms of impact certainty and consideration of available information. The Precautionary Principle is applied in line with South Africa's National Environmental Management Act, 1998 (Act No. 107 of 1998) in instances of uncertainty or lack of information, by increasing assigned ratings or adjusting final model outcomes. In certain instances, where a variable or outcome requires rational adjustment due to model limitations, the model outcomes have been adjusted.

"RISK ASSESSMENT KEY" (Based on DWS 2015 publication: Section 21 c and i water use Risk Assessment Protocol)

[3] The definition has been aligned with that used in the ISO 14001 Standard.

[4] Some risks/impacts that have low significance will however still require mitigation

Table D1: Severity (How severe does the aspects impact on the resource quality (flow regime, water quality, geomorphology, biota, habitat)

Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3
Great / harmful	4
Disastrous / extremely harmful and/or wetland(s) involved	5
Where "or wetland(s) are involved" it means that the activity is located within the delineated boundary of any wetland. The score of 5 is only compulsory for the significance rating.	

Table D2: Spatial Scale (How big is the area that the aspect is impacting on)

Area specific (at impact site)	1
Whole site (entire surface right)	2
Regional / neighbouring areas (downstream within quaternary catchment)	3
National (impacting beyond secondary catchment or provinces)	4
Global (impacting beyond SA boundary)	5

Table D3: Duration (How long does the aspect impact on the resource quality)

One day to one month, PES, EIS and/or REC not impacted	1
One month to one year, PES, EIS and/or REC impacted but no change in status	2
One year to 10 years, PES, EIS and/or REC impacted to a lower status but can be improved over this period through mitigation	3
Life of the activity, PES, EIS and/or REC permanently lowered	4
More than life of the organisation/facility, PES and EIS scores, a E or F	5
PES and EIS (sensitivity) must be considered.	

Table D4: Frequency of the activity (How often do you do the specific activity)

Annually or less	1
6 monthly	2
Monthly	3
Weekly	4
Daily	5

Table D5: The frequency of the incident or impact (How often does the activity impact on the resource quality)

Almost never / almost impossible / >20%	1
Very seldom / highly unlikely / >40%	2
Infrequent / unlikely / seldom / >60%	3
Often / regularly / likely / possible / >80%	4
Daily / highly likely / definitely / >100%	5

Table D6: Legal issues (How is the activity governed by legislation)

No legislation	1
Fully covered by legislation (wetlands are legally governed)	5
Located within the regulated areas	

Table D7: Detection (How quickly or easily can the impacts/risks of the activity be observed on the resource quality, people and resource)

Immediately	1
Without much effort	2
Need some effort	3
Remote and difficult to observe	4
Covered	5

Table D8: Rating Classes

RATING	CLASS	MANAGEMENT DESCRIPTION
1 – 55	(L) Low Risk	Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated.
56 – 169	M) Moderate Risk	Risk and impact on watercourses are notably and require mitigation measures on a higher level, which costs more and require specialist input. Licence required.
170 – 300	(H) High Risk	Watercourse(s) impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve. Licence required.

A low risk class must be obtained for all activities to be considered for a GA

Table D9: Calculations

Consequence = Severity + Spatial Scale + Duration
Likelihood = Frequency of Activity + Frequency of Incident + Legal Issues + Detection
Significance\Risk = Consequence X Likelihood

The following points were considered when undertaking the assessment:

- Risks and impacts were analysed in the context of the *project's area of influence* encompassing:
  - Primary project site and related facilities that the client and its contractors develops or controls;
  - Areas potentially impacted by cumulative impacts for further planned development of the project, any existing project or condition and other project-related developments; and
  - Areas potentially affected by impacts from unplanned but predictable developments caused by the project that may occur later or at a different location.
  - Risks/Impacts were assessed for construction phase and operational phase; and
- Individuals or groups who may be differentially or disproportionately affected by the project because of their disadvantaged or vulnerable status were assessed.

Control Measure Development

The following points presents the key concepts considered in the development of mitigation measures for the proposed construction:

- Mitigation and performance improvement measures and actions that address the risks and impacts[5] are identified and described in as much detail as possible. Mitigating measures are investigated according to the impact minimisation hierarchy as follows:
  - Avoidance or prevention of impact;
  - Minimisation of impact;
  - Rehabilitation; and
  - Offsetting.
- Measures and actions to address negative impacts will favour avoidance and prevention over minimisation, mitigation or compensation; and

[5] Mitigation measures should address both positive and negative impacts

- Desired outcomes are defined and have been developed in such a way as to be measurable events with performance indicators, targets and acceptable criteria that can be tracked over defined periods, wherever possible.

Recommendations

Recommendations were developed to address and mitigate potential impacts on the freshwater ecology of the resources in traversed by or in close proximity of the proposed infrastructure.

Reversibility and/or irreplaceable loss

The following indicates the rationale for the reversibility scoring in relation to the watercourses.

Table D10: Reversibility of impacts on the watercourse

Reversibility Rating:	Irreversible (the activity will lead to an impact that is permanent)
	Partially reversible (The impact is reversible to a degree e.g. acceptable revegetation measures can be implemented but the pre-impact species composition and/or diversity may never be attained. Impacts may be partially reversible within a short (during construction), medium (during operation) or long term (following decommissioning) timeframe
	Fully reversible (The impact is fully reversible, within a short, medium or long-term timeframe)

APPENDIX E – Results of the Ecological Assessments

Table E1: Index of Habitat Integrity (IHI)

	MRU
INSTREAM IHI	
Base Flows	-3.0
Zero Flows	-0.5
Floods	-3.5
HYDROLOGY RATING	**2.0**
pH	2.5
Salts	3.5
Nutrients	3.5
Water Temperature	2.0
Water clarity	-2.5
Oxygen	-3.5
Toxics	2.5
PC RATING	**3.0**
Sediment	3.5
Benthic Growth	2.0
BED RATING	**2.5**
Marginal	2.0
Non-marginal	4.0
BANK RATING	**2.8**
Longitudinal Connectivity	-2.0
Lateral Connectivity	-3.0
CONNECTIVITY RATING	**2.4**
INSTREAM IHI %	**50.1**
INSTREAM IHI EC	**D**
INSTREAM CONFIDENCE	**3.7**

	MRU
RIPARIAN IHI	
Base Flows	-3.5
Zero Flows	-1.5
Moderate Floods	-3.5
Large Floods	-2.5
HYDROLOGY RATING	**2.7**
Substrate Exposure (marginal)	1.0
Substrate Exposure (non-marginal)	1.0
Invasive Alien Vegetation (marginal)	3.0
Invasive Alien Vegetation (non-marginal)	4.0
Erosion (marginal)	
Erosion (non-marginal)	
Physico-Chemical (marginal)	2.0
Physico-Chemical (non-marginal)	3.5
Marginal	3.0
Non-marginal	4.0
BANK STRUCTURE RATING	**3.5**
Longitudinal Connectivity	3.0
Lateral Connectivity	4.0
CONNECTIVITY RATING	**3.5**
RIPARIAN IHI %	**35.1**
RIPARIAN IHI EC	**E**
RIPARIAN CONFIDENCE	**3.5**

Table E2: Invertebrate Habitat Assessment System (IHAS)

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name: Bot River						
Site Name: Bot River downstream Erin de Vigne Dam	**Date: 11 November 2022**					
SAMPLING HABITAT	**0**	**1**	**2**	**3**	**4**	**5**
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min)	0	<1	>1-2	2	>2-3	>3
(* NOTE: up to 25% of stone is usually embedded in the stream bottom)						
	SIC Score (max 20):				**0**	
VEGETATION	**0**	**1**	**2**	**3**	**4**	**5**
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none		1-25	26-50	51-75	>75
	Vegetation Score (max 15):				**17**	
OTHER HABITAT/GENERAL	**0**	**1**	**2**	**3**	**4**	**5**
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
(** NOTE: you must still fill in the SIC section)						
	Other Habitat Score (max 20):				**11**	
	HABITAT TOTAL (MAX 55):				**28**	
STREAM CONDITION	**0**	**1**	**2**	**3**	**4**	**5**
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>1	1	>½-1	½	<½-¼	<¼
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	50-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
	STREAM CONDITIONS TOTAL (MAX 45):					**29**
	TOTAL IHAS SCORE (%):				**57**	

Table E3: South African Scoring System (Version 5) results

ORDER	FAMILY	SENSITIVITY	SITE TOTAL VEG+MUD
TURBELLARIA		3	5
ANNELIDA	Oligochaeta	1	2
HYDRACARINA		8	3
EPHEMEROPTERA	Baetidae sp. (x)	4	30
	Baetidae sp. (y)	6	30
	Baetidae sp. (z)	12	30
ODONATA	Coenagrionidae	4	20
	Aeshnidae	8	1
	Corduliidae	8	8
LEPIDOPTERA	Pyralidae	12	
HEMIPTERA	Belostomatidae*	3	20
	Corixidae*	3	5
	Gerridae*	5	2
	Hydrometridae*	6	1
	Notonectidiae*	3	2
	Veliidae/Mesoveliidae*	5	8
COLEOPTERA	Dytiscidae*	5	1
	Hydrophilidae*	5	2
DIPTERA	Ceratopogonidae	5	5
	Chironomidae	2	100
	Culicidae*	1	2
	Dixidae*	10	1
GASTROPODA	Planorbidae*	3	30
	SASS SCORE		**100**
	NUMBER OF FAMILIES		**20**
	ASPT		**5**
	ECOLOGICAL CONDITION		**B**

Table E4: Macro-Invertebrate Response Assessment Index

INVERTEBRATE EC METRIC GROUP		METRIC GROUP CALCULATED SCORE	CALCULATED WEIGHT	WEIGHTED SCORE OF GROUP	RANK OF METRIC	%WEIGHT FOR METRIC GROUP
FLOW MODIFICATION	**FM**	49.6	*0.280*	13.8923	2	70
HABITAT	**H**	74.2	*0.400*	29.6923	1	100
WATER QUALITY	**WQ**	52.0	*0.200*	10.4	3	50
CONNECTIVITY & SEASONALITY	**CS**	100.0	*0.120*	12	4	30
						250
INVERTEBRATE EC				65.9846		
INVERTEBRATE EC CATEGORY				**C**		

Table E5: Ecological Importance and Sensitivity (EIS)

ECOLOGICAL IMPORTANCE & SENSITIVITY - Bot River		
CRITERIA	**EIS Scores**	**Confidence**
BIOTIC		
Rare & endangered biota	1	High
Unique biota	2	Medium
Intolerant (i.e. sensitive) biota	2	High
Species/taxon richness	2	High
Median score (Biotic criteria)	**2 (HighEIS)**	**Medium**
HABITAT		
Diversity of aquatic habitat types	2	Medium
Refuge value of habitat types	3	Medium
Sensitivity of habitat to flow changes	2	Medium
Sensitivity of habitat to WQ changes	1	Medium
Migration route/corridor	4	High
Protected/natural areas	4	High
Median score (Habitat criteria)	**2.5 Very High EIS)**	**Medium**
Overall median score	**2.3 (High EIS)**	**Medium**

Table E6: Diatom community analysis results for the Bot River plant sample

Sample Bot River					
Dominant Specie 1: *Melosira varians*		**Dominant Species 1 Ecology:** This cosmopolitan taxon is found in both the benthos as well as the plankton and becomes particularly abundant in eutrophic, occasionally slightly brackish, waters.			
Dominant Specie 2: *Fragilaria ulna*		**Dominant Species 2 Ecology:** This cosmopolitan taxon is found in the benthos of rivers and lakes and is easily suspended in the plankton due to its relatively large surface area. Found in mesotrophic to eutrophic, alkaline freshwaters. Living cells are usually apically attached to a substratum.			
Number of Species:	14	**Diatom Index Scores**			
Diversity:	3.65	**SPI**	**GDI**	**TDI**	**%PTV**
Evenness:	0.96	12.1	11.8	9.2	0
Deformities (%):	None	**Trophic level:**	**Ecosystem Quality:**		**Ecological category:**
		Mesotrophic	Moderate Quality		**C**

Overall:

- Site Bot River Plants has a high species diversity with an even species distribution;
- The SPI and GDI scores are indicative of mesotrophic conditions and classifies the site in a Moderate ecological condition (Category C);
- A low TDI are indicative of Oligotrophic conditions with no pollution present at the site in the form of organic pollution as supported by the low %PTV (0.0%) score;
- The ecology of both dominant diatom species identified (*M. varians* and *F. ulna*) are synonymous with nutrient enriched ecosystems and are normally found in meso-eutrophic waters with *F. ulna* present in alkaline freshwater. *M. varians* are occasionally found in slightly brackish waters. The presence of the dominant species together with the measured SPI index score (final score calculated based on the diatom community as a whole) are indicators of a moderate to elevated nutrient enriched ecosystem at the site at the time of the assessment with little to no organic pollution present based on the diatom community results; and
- **Overall:** Diatom results indicate a moderate ecosystem quality for site Bot River Plants with meso-eutrophic nutrient enrichment at the site at the time of assessment.

Table E7: Diatom community of the Bot River plant sample

Species	Counts	Abundances
Melosira varians Agardh	58	14,50
Fragilaria ulna (Nitzsch.) Lange-Bert. var. biceps (Kützing) Lange-Be	44	11,00
Gomphonema truncatum Ehr.	36	9,00
Cyclotella meneghiniana Kützing	35	8,75
Fragilaria spp. H.C. Lyngbye	35	8,75
Cocconeis placentula Ehrenberg	32	8,00
Gomphonema acuminatum Ehrenberg	32	8,00
Bacillaria paradoxa Gmelin	29	7,25
Nitzschia spp. A.H. Hassall	27	6,75
Gomphonema affine Kützing	22	5,50
Gomphonema italicum Kützing	18	4,50
Tabellaria flocculosa (Roth) Kützing	15	3,75
Staurosirella spp. D.M. Williams & F.E. Round emend Morales	9	2,25
Gyrosigma acuminatum (Kützing) Rabenhorst	8	2,00
TOTAL	**400**	

Table E8: Diatom community of the Dam cobble sample

<table>
<tr><td colspan="6">Sample Dam</td></tr>
<tr><td colspan="2">Dominant Specie 1: Eunotia minor</td><td colspan="4">Dominant Species 1 Ecology:
Occurs in circumneutral waters, in pools and springs.</td></tr>
<tr><td colspan="2">Dominant Specie 2: Navicula spp.</td><td colspan="4">Dominant Species 2 Ecology:
A cosmopolitan species occuring in a wide variety of waters ranging from humic, weakly acidic, oligotrophic, electrolyte poor waters to strongly alkaline, eutrophic, calcareous waters. This species is however, very sensitive to organic pollution.</td></tr>
<tr><td>Number of Species:</td><td>17</td><td colspan="4">Diatom Index Scores</td></tr>
<tr><td>Diversity:</td><td>4.03</td><td>SPI</td><td>GDI</td><td>TDI</td><td>%PTV</td></tr>
<tr><td>Evenness:</td><td>0.99</td><td>11.2</td><td>12.3</td><td>12.2</td><td>10</td></tr>
<tr><td>Deformities (%):</td><td>None</td><td>Trophic level:</td><td colspan="2">Ecosystem Quality:</td><td>Ecological category:</td></tr>
<tr><td></td><td></td><td>Meso-eutrophic</td><td colspan="2">Moderate quality</td><td>C/D</td></tr>
<tr><td colspan="6">Overall:
➢ Site Bot Dam Cobbles has a high species diversity and even species distribution, species diversity and evenness slightly increasing compared to site Bot River Plants;
➢ The SPI and GDI scores are indicative of meso-eutrophic conditions and classifies the site in a Moderate ecological condition (Category C/D);
➢ A low TDI score are indicative of Oligotrophic conditions with no pollution present at the site in the form of organic pollution as supported by the low %PTV (10.0%) score;
➢ The ecology of the dominant diatom specie identified (E. minor) is an indicator of circumneutral waters. Navicula spp. has a wide range of preferred ecological conditions ranging from oligotrophic to eutrophic conditions, thus the SPI scores calculations are considered as the SPI's final score is calculated on the diatom community as a whole. However, Navicula spp. is very sensitive to organic pollution and thus the presence of the species indicates to organic pollution at the site at the time of assessment as supported by the TDI and %PTV index scores. The final calculated SPI score indicates the site as moderately to highly nutrient enriched and in a Moderate ecological quality (Category C/D); and
➢ Overall: The diatom results indicate that site Bot Dam Cobbles mesotrophic to eutrophic conditions with no organic pollution present at the site. The site is classified as Moderate quality (Category C/D). Spatially between sites Bot River Plants and Bot Dam Cobbles a slight decrease in ecosystem quality is noted at site Bot Dam Cobbles. Both sites compared the trophic level of Bot Dam Cobbles (Category C) is meso-eutrophic with Bot River Plants (Category C) as mesotrophic.</td></tr>
</table>

Table E9: Diatom species list and % abundance for the Dam cobble sample

Species	Counts	Abundances
Eunotia minor (Kützing) Grunow in Van Heurck	35	8,75
Navicula spp. J.B.M. Bory de St. Vincent	35	8,75
Mastogloia elliptica (C.A. Agardh) Cleve	34	8,50
Cocconeis placentula Ehrenberg var. placentula	31	7,75
Cyclotella meneghiniana Kützing	30	7,50
Gomphonema spp. C.G. Ehrenberg	25	6,25
Gomphonema affine Kützing	23	5,75
Fragilaria biceps (Kützing) Lange-Bertalot	22	5,50
Frustulia crassinervia (Breb.) Lange-Bertalot et Krammer	22	5,50
Nitzschia spp. A.H. Hassall	21	5,25
Nitzschia palea (Kützing) W.Smith	20	5,00
Tryblionella gracilis W. Smith	20	5,00
Navicula radiosa Kützing	19	4,75
Amphora spp. C.G. Ehrenberg ex F.T. Kützing	17	4,25
Cymbella tumida (Brebisson)Van Heurck	17	4,25
Aulacoseira granulata (Ehr.) Simonsen	16	4,00
Pinnularia spp. C.G. Ehrenberg	13	3,25
TOTAL	**400**	

APPENDIX F – Risk Assessment Summary

Table F1: Summary results of the DWS Risk Assessment applied to the Bot River for the significance of the Alternative (Alternative 1) – Dam1 expansion and Preferred (Alternative 2) new dam downgradient of Dam 1 activities and Alternative and Preferred cultivation area activities downstream of Dam 1.

Phase	Activity	Aspect	Impact	Flow Regime	Physico & Chemical (Water Quality)	Habitat (Geomorph+ Vegetation)	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating
CONSTRUCTION	Site preparation prior to construction activities (applicable to the expansion of Dam1 or proposed dam directly downgradient of Dam 1) and the proposed vineyard areas downgradient)	➢ Vehicular movement (transportation of construction materials and access to the sites)	➢ Transportation of construction materials can result in disturbances to soil, and increased risk of sedimentation to downstream Bot River; and ➢ Soil and stormwater contamination from oils and hydrocarbons originating from construction vehicles that may be flushed into the Bot River	1	2	1	1	1.25	1	1	3.25	5	1	5	3	14	45.5	L
		➢ Removal of vegetation and disturbance to soil associated with the proposed dam directly downgradient of Dam 1 and proposed vineyard	➢ Sediment transported as runoff into the downgradient Bot River; ➢ Exposure of soil, leading to increased runoff, and erosion, and thus increased sedimentation of the Bot River; and ➢ Proliferation of alien vegetation as a result of disturbances.	1	1	2	1	1.25	1	1	3.25	5	2	5	3	15	48.75	L
	Construction activities applicable to the expansion of Dam 1 or proposed dam directly downgradient of Dam 1 and proposed vineyards downgradient	➢ Excavation of dam basin to source fill material; ➢ Stockpiling of material; ➢ Infilling and compaction of the proposed dam wall footprint.	➢ Runoff from stockpiled material or sediment laden runoff from the construction footprint area could enter the downstream Bot River and increase its sediment load;	1	2	2	1	1.5	1	1	3.5	5	2	5	3	15	52.5	L
	Rehabilitation requirements surrounding Dam 1 or the proposed dam downgradient of Dam 1 and associated vineyards downgradient	Post construction rehabilitation to maintain ecological condition	➢ AIP proliferation; ➢ New erosion and incision due to the expanded dam walls; and ➢ Litter and waste removal.	1	1	1	3	1.5	1	3	5.5	2	2	5	1	10	55	L
OPERATION	Operation of expanded Dam 1 or the proposed dam directly downgradient of Dam 1 and associated vineyards downgradient	Overflow of the dam once full capacity has been reached.	➢ Potential overtopping of the dam and the flushing of sediment laden runoff into the downgradient Bot River.	1	2	2	1	1.5	3	2	6.5	1	1	5	1	8	52	L
		Routine maintenance (including desilting activities) leading to increased vehicle access.	➢ Soil compaction and disturbance around the dam; ➢ Staff operation of the vineyard; ➢ Potential sedimentation of downstream Bot River; and ➢ Vegetation degradation and alien invasive proliferation.	1	1	2	2	1.5	1	1	3.5	4	2	5	1	12	42	L

APPENDIX G – Details, Expertise and Curriculum Vitae of Specialists

1. (a) (i) Details of the specialist who prepared the report

Cole Grainger MSc Conservation Ecology (University of Stellenbosch)
Leandra Jonker MSc Aquatic Health (University of Johannesburg)
Stephen van Staden MSc Environmental Management (University of Johannesburg)

1. (a). (ii) The expertise of that specialist to compile a specialist report including a curriculum vitae

Company of Specialist:	FEN Consulting (Pty) Ltd		
Name / Contact person:	Cole Grainger		
Postal address:	221 Riverside Lofts, Tygerfalls Boulevard, Bellville,		
Postal code:	7539	Cell:	084 397 6753
Telephone:	011 616 7893 (head office)	Fax:	086 724 3132
E-mail:	cole@sasenvgroup.co.za		
Qualifications	MSc (Conservation Ecology) (University of Stellenbosch)		
Registration / Associations	Registered Candidate Scientist at South African Council for Natural Scientific Professions (SACNASP)		

1. (b) a declaration that the specialist is independent in a form as may be specified by the competent authority

I, Cole Grainger, declare that -

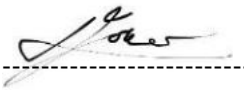
- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity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

Signature of the Specialist

1. (b) a declaration that the specialist is independent in a form as may be specified by the competent authority

I, Leandra Jonker, declare that -

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

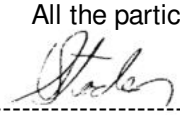


Signature of the Specialist

1. (b) a declaration that the specialist is independent in a form as may be specified by the competent authority

I, Stephen van Staden, declare that -

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



Signature of the Specialist

SAS ENVIRONMENTAL GROUP OF COMPANIES –

SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF COLE GRAINGER

PERSONAL: DETAILS

Position in Company	Freshwater Specialist
Joined SAS Environmental Group of Companies	2022

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Candidate member of the South African Council for Natural Scientific Professions (SACNASP – Reg No. 119870)

EDUCATION

Qualifications

MSc Conservation Ecology (Stellenbosch University)	2017
BSc Conservation Ecology (Stellenbosch University)	2010

Short Courses

Tools for Wetland Assessment (Rhodes University)	2020
SASS5 National Aquatic Ecosystem Health Monitoring Programme	2018

AREAS OF WORK EXPERIENCE

South Africa-Western Cape

KEY SPECIALIST DISCIPLINES

Freshwater Assessments

- Desktop Freshwater Delineation
- Freshwater Verification Assessment
- Freshwater (wetland / riparian) Delineation and Assessment
- Freshwater Eco Service and Status Determination

Aquatic Ecological Assessment and Water Quality Studies

- Water quality Monitoring
- SASS Monitoring
- Benthic Algal Monitoring
- Wetland Monitoring

Legislative Requirements, Processes and Assessments

- Water Use Applications (Water Use Licence Applications / General Authorisations)

SAS ENVIRONMENTAL GROUP OF COMPANIES –

SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF LEANDRA JONKER

PERSONAL DETAILS

Position in Company	Aquatic Ecologist
Joined SAS Environmental Group of Companies	2012

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP)
Accredited River Health practitioner by the South African River Health Program (RHP)
Southern African Society of Aquatic Scientists

EDUCATION

Qualifications

MSc Aquatic Health (University of Johannesburg)	2015
BSc Environmental Management (Hons) (University of South Africa)	2011
BSc Botany and Zoology (North-West University)	2009

AREAS OF WORK EXPERIENCE

South Africa – Gauteng, Mpumalanga, North West, Limpopo, KwaZulu-Natal, Free State

KEY SPECIALIST DISCIPLINES

Aquatic Ecological Assessment and Water Quality Studies

- Habitat Assessment Indices (IHAS, HRC, IHIA, IHI & RHAM)
- Aquatic Macro-Invertebrate Community Integrity Assessments (SASS5 & MIRAI)
- Fish Community Integrity Assessments (FRAI)
- Fish Health Assessments
- Diatom Community Assessments
- Riparian Vegetation Integrity Assessments (VEGRAI)
- Toxicological Analysis
- Water quality Monitoring
- Sediment Chemical Analysis
- Riverine Rehabilitation Plans

Legislative Requirements, Processes and Assessments

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

SAS ENVIRONMENTAL GROUP OF COMPANIES –

SPECIALIST CONSULTANT INFORMATION

CURRICULUM VITAE OF STEPHEN VAN STADEN

PERSONAL DETAILS

Position in Company	Group CEO, Water Resource Discipline Lead, Managing Member, Ecologist, Aquatic Ecologist
Joined SAS Environmental Group of Companies	2003 (year of establishment)

MEMBERSHIP IN PROFESSIONAL SOCIETIES

Registered Professional Scientist at South African Council for Natural Scientific Professions (SACNASP)
Accredited River Health Practitioner by the South African River Health Program (RHP)
Member of the South African Soil Surveyors Association (SASSO) Member of the Gauteng Wetland Forum
Member of the Gauteng Wetland Forum
Member of International Association of Impact Assessors (IAIA) South Africa;
Member of the Land Rehabilitation Society of South Africa (LaRSSA)

EDUCATION

Qualifications

MSc Environmental Management (University of Johannesburg)	2003
BSc (Hons) Zoology (Aquatic Ecology) (University of Johannesburg)	2001
BSc (Zoology, Geography and Environmental Management) (University of Johannesburg)	2000

Short Courses

Integrated Water Resource Management, the National Water Act, and Water Use Authorisations, focusing on WULAs and IWWMPs	2017
Tools for Wetland Assessment (Rhodes University)	2017
Legal liability training course (Legricon Pty Ltd)	2018
Hazard identification and risk assessment training course (Legricon Pty Ltd)	2018
Wetland Management: Introduction and Delineation (WLID1502S) (University of the Free State)	2018
Hydropedology and Wetland Functioning (TerraSoil Science and Water Business Academy)	2018

AREAS OF WORK EXPERIENCE

South Africa – All Provinces
Southern Africa – Lesotho, Botswana, Mozambique, Zimbabwe Zambia
Eastern Africa – Tanzania Mauritius
West Africa – Ghana, Liberia, Angola, Guinea Bissau, Nigeria, Sierra Leona
Central Africa – Democratic Republic of the Congo

DEVELOPMENT SECTORS OF EXPERIENCE

1. Mining: Coal, chrome, Platinum Group Metals (PGMs), mineral sands, gold, phosphate, river sand, clay, fluorspar
2. Linear developments (energy transmission, telecommunication, pipelines, roads)
3. Minerals beneficiation
4. Renewable energy (Hydro, wind and solar)
5. Commercial development
6. Residential development
7. Agriculture
8. Industrial/chemical

KEY SPECIALIST DISCIPLINES

Legislative Requirements, Processes and Assessments

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

Freshwater Assessments

- Freshwater (wetland / riparian) Delineation and Assessment
- Freshwater Eco Service and Status Determination
- Rehabilitation Assessment / Planning
- Maintenance and Management Plans
- Plant Species and Landscape Plans
- Freshwater Offset Plans
- Hydropedological Assessment
- Pit Closure Analysis

Aquatic Ecological Assessment and Water Quality Studies

- Habitat Assessment Indices (IHAS, HRC, IHIA & RHAM)
- Aquatic Macro-Invertebrates (SASS5 & MIRAI)
- Fish Assemblage Integrity Index (FRAI)
- Fish Health Assessments
- Riparian Vegetation Integrity (VEGRAI)
- Toxicological Analysis
- Water quality Monitoring
- Screening Test
- Riverine Rehabilitation Plans

Biodiversity Assessments

- Floral Assessments
- Biodiversity Actions Plan (BAP)
- Biodiversity Management Plan (BMP)
- Alien and Invasive Control Plan (AICP)
- Ecological Scan
- Terrestrial Monitoring
- Biodiversity Offset Plan

Soil and Land Capability Assessment

- Soil and Land Capability Assessment
- Hydropedological Assessment

Visual Impact Assessment

- Visual Baseline and Impact Assessments
- Visual Impact Peer Review Assessments