APPENDIX G1: AQUATIC IMPACT ASSESSMENT

HUGOSDALE FARM (RE/141) DAM 2 EXPANSION, GREYTON, WESTERN CAPE PROVINCE.

AQUATIC IMPACT ASSESSMENT

Prepared by:

EOH Coastal & Environmental Services
1 Osborne Road, Gillooly's View
EOH Business Park, Block D
Bedfordview, 2007
South Africa

Also in Grahamstown, Port Elizabeth, East London, Cape Town and Maputo
www.cesnet.co.za

Prepared for:

Wijnberg Farm Trust

SEPTEMBER 2018

EXECUTIVE SUMMARY

INTRODUCTION

The Wijnberg Farm Trust proposes to enlarge Dam 2 on Hugosdale Farm (RE/141), near Greyton in the Western Cape. The expansion of the dam will be done by constructing a new dam wall (>5m) that will inundate the existing dam and increase its surface area from 5 500m^2 to 65 500m^2, an increase of 60 000m^2. The overall dam capacity will increase from 56 965 m^3 to 500 000 m^3 (i.e. increase of 443 035 m^3).

The purpose of the proposed development is to increase the water availability on the farm for the irrigation of new deciduous fruit trees and cattle feed grass, as well as reduce electricity consumption by increasing gravity feed irrigation.

The following infrastructure will be required as part of the proposed activity:

- Dam wall;
- Spillway; and
- Laydown area.

TERMS OF REFERENCE

The following terms of reference apply to this report:

- Establish the ecological baseline status and general health of the river adjacent to the existing Dam 2, in terms of invertebrate indicator species;
- Determine the ecological importance of the river system;
- Identify general upstream and downstream water use activities; and
- Determine the impacts and severity for the proposed Dam 2 expansion on the riverine ecology.

The assessment of invertebrate composition was conducted to form a baseline from which to determine future impacts, and to inform the existing pollution levels and pollution sources likely to be present on site. No organic or chemical testing (physico-chemical properties) was deemed necessary at this stage.

METHOD

Biological response data (aquatic biomonitoring) provide an integrated indication of the effects of the many potential physical, biological and chemical stressors that coexist in aquatic ecosystems. Macroinvertebrate community structure, measured as taxonomic richness and diversity, has been the approach most readily investigated and applied (Peru and Doledec 2010). The South African Scoring System (SASS) version 5 (Dickens and Graham 2002) is the most popular macroinvertebrate rapid bioassessment tool in use in South Africa.

Three invertebrate samples from identified sites were collected employing the SASS 5 methodology, and data was analysed to provide baseline levels for the invertebrate composition, and to determine the ecological condition found at each sample site.

ASSUMPTIONS AND LIMITATION

The following assumptions and limitations applied to this study:

- Data on aquatic species in smaller, outlying systems such as this are not commonly available. It was therefore necessary to assume that a number of species of special concern, rare and endangered species, and undescribed species possibly occur within the study area.

RESULTS AND CONCLUSION

A total of 32 aquatic macro-invertebrate taxa (from 11 different families) were found within the sampled river. The number of aquatic macroinvertebrate taxa sampled ranged from 11 at the midstream site (S2), to 22 found at the upstream site (S1), which reflected an overall highly diverse community of invertebrates within the stream.

Furthermore, the *Ephemeroptera, Plecoptera and Trichoptera* (EPT) Taxa Richness Metric was used to indicate the level of degradation of these sites, indicated in the table below.

Table 1. EPT richness of each site.

Sample Site	# of taxa	# of EPT taxa	EPT richness (%)
Site S1	22	9	40
Site S2	11	3	27
Site S3	19	8	42

In terms of the SASS methodology three principal indices are calculated, namely the SASS Score, the Number of taxa, and the Average Score per Taxon (ASPT). By dividing the SASS Score with the Number of taxa identified, the ASPT is calculated. The ASPT score is then used to define the Present Ecological State (PES). The PES scores for each of the sites are provided below, using the Southern Coastal Belt (lower) ecoregion categories.

Table 2. SASS score, Average Score Per Taxon and Present Ecological State of the rivers sampled.

Metric	**Site S1**	**Site S2**	**Site S3**
SASS score	157	54	115
no. of taxa	22	11	19
ASPT	7.1	4.9	6.0
PES Category	**A**	**D**	**B**
PES Name	Natural	Poor	Good
PES Description	Unmodified natural	Largely modified	Largely natural with few modifications

The results from the study indicated a highly diverse invertebrate community within the river, with relatively low to moderate abundance for most taxa. This indicates good water quality in a healthy aquatic ecosystem. Site S1, the upstream site, showed the greatest ecological function, with a PES category of A – Natural, as compared to the two other sites. Site S2, the midstream site (adjacent to the existing dam) showed poor water quality, potentially due to reduced visibility (greater turbidity and poorer clarity), as well as sedimentation and changes to the hydrological regime in the existing dam. These impacts largely seem absent further downstream at Site S3, where good quality water, clarity and taxa composition had returned.

The results indicate that the existing dam impacts on the water quality, in terms of invertebrate taxa and composition, to a limited extent. Impacts are largely corrected again at the S3 location downstream, indicating that the impacts of the dam are reduced further downstream, and that the system is resilient enough to recover from any impacts associated with the current dam.

Impacts identified for the proposed development are summarised below.

Table 3. Impacts summary from the impacts chapter.

Impact	Significance pre-mitigation	Significance post-mitigation	Mitigation measures (summarised – see Chapter 7 for complete descriptions)
CONSTRUCTION PHASE			
Impact 1.1: Sedimentation and elevated turbidities	**HIGH -**	**LOW -**	• Undertake construction activities during the dry summer months. • Prevent or limit disturbance to water resources. • Contain any soils that may be eroded by heavy rainfall, and rehabilitate as soon as possible after. • Establish adequate surface drainage systems. • Maintain maximum vegetation cover outside the clearing zone. • Natural drainage lines must not be impeded or otherwise interfered with. • Erosion should be monitored over the entire site and corrective actions taken where needed.
Impact 1.2: Contamination from pollutants	**MODERATE-**	**LOW-**	• Strict management of hazardous chemicals must be implemented. • Prevent of hydrocarbon spills from machinery and vehicles. • Safely store and dispose of domestic effluent from the construction camps. • All contaminated water run-off from the site must be contained and treated prior to discharge.
Impact 2.1: Habitat Modification	**HIGH-**	**LOW-**	• Slash and debris should be stockpiled above the new high water mark. • Minimise the number and size of stream crossings for vehicle movement.
Impact 2.2: Flow Modification	**MODERATE-**	NEGLIGIBLE-	• Plan construction within the dry months of the year. • Plan construction phases and activities to minimise the disruption to the stream location and hydrological regime. • Plan access for vehicles and materials via the western access road.
OPERATIONAL PHASE			
Impact 3.1: Sedimentation and elevated turbidities in streams/dams	**LOW -**	**LOW -**	In addition to the mitigation measures stipulated for the construction phase in Section 7.3.1, the following is also recommended: • The spillway must be designed to ensure an even, slow release of water from the dam when it is at full supply level (FSL), to reduce any erosion of the spillway. • Appropriate engineering designs must be implemented to reduce spillway erosion and minimise flood risks, including the use of concrete step designs and geotextiles to trap ejected sediment (or another suitable design).

Impact 4.1: Flow modification	**HIGH-**	**MODERATE-**	• Ensure that the Ecological Flow Reserve (EFR) is maintained, no matter the water level of the dam. • Ensure that the design accounts for the release of water to meet the EFR.

In order to address the two largest impacts, that of habitat modification and flow modification, the following monitoring plan is suggested (Table 4). Should monitoring results indicate a significant increase in turbidity levels and/or a change in Ecological Flow Reserve (when compared to the pre-construction monitoring findings), immediate corrective action should be taken to reduce the impacts on the stream and the aquatic environment.

Table 4. Suggested monitoring programme to ensure ongoing impacts to the aquatic environment are identified and addressed as soon as possible.

Pre - Construction phase			
Monthly wet season turbidity monitoring for 2019.	S1	34° 3'50.23"S	19°40'33.02"E
	S2	34° 4'3.12"S	19°40'27.06"E
	S3	34° 4'16.99"S	19°40'21.93"E
	S4	34° 4'24.36"S	19°40'20.21"E
	S5	34° 4'35.91"S	19°40'14.39"E
Operation phase			
Monthly wet season turbidity monitoring for the first two years following inundation.	S1	34° 3'50.23"S	19°40'33.02"E
	S3	34° 4'16.99"S	19°40'21.93"E
	S5	34° 4'35.91"S	19°40'14.39"E
Monthly monitoring of dam release quantity.		At dam outlet	
Monthly rainfall monitoring.		At proposed dam site	

The Dam 5 expansion alternative is the preferred option, as it has fewer aquatic ecosystem health impacts. The expansion of Dam 2 is regarded as the second best option should Dam 5 not be regarded as feasible. Overall, all of the HIGH rated impacts can be reduced to MODERATE or LOW, with mitigation. Habitat modification and flow modification are the two most important impacts. Particular care should be taken to mitigate these impacts during the design phase, and a suitable construction layout, design and methodology should be selected to reduce the severity of these impacts.

Should either option Dam 5 or Dam 2 be selected, the specialist is of the opinion that the impacts can be reduced to acceptable levels, provided that the mitigation measures are implemented rigorously. Thus, that the proposed development can proceed from an aquatic ecosystem perspective, should it be approved by the Competent Authority.

THE AUTHOR AND SPECIALIST

Mr Justin Green – (Aquatic Ecologist & Report Review)
Justin has a BSc. degree in Zoology and Entomology as well as a Post Graduate Diploma in Enterprise Management from Rhodes University. Justin has been an Environmental Consultant with CES for 6 years and has been involved in extensive work in Renewable Energy Projects and mining based projects. Justin has been involved in both Environmental Impact Assessment as well as Basic Assessments in South Africa as well as numerous internationally based projects.

He has 5 years of progressive experience encompassing both the public and private sectors, specializing in Water Resources Management and Aquatic Biomonitoring and Assessment using the South African Scoring System (SASS5) methodology. SASS5 is based on the presence or absence of sensitive aquatic macroinvertebrates collected and analysed according to the methods outlined in Dickens and Graham (2002). Reports have been completed to both IFC and World Bank standards, with laboratory results being compared to International guidelines such as ANZECC and WHO. His work experience has been completed in South Africa, Lesotho, Cameroon, the DRC as well as numerous projects in Mozambique.

Justin is also part of the Geographical Information Systems (GIS) team for the past 5 years with his primary experience through ArcGIS 10.1 and Quantum GIS 2.8.3. He has been involved in producing mapping data for a multitude of projects all up to IFC and World Bank standards. Justin has also made a considerable difference using OruxMaps for the purpose of specialist fieldwork and mapping purposes.

Mr Gideon Raath (Author), Pr.Sci.Nat.
Mr Gideon Raath, (Environmental Consultant) holds an MSc (Geography and Environmental Management; SU), a BSc Honours (Ecology and Environmental Studies - Cum laude; Wits) and a BSc (Geography and Environmental Management; UJ). His MSc thesis focussed on the hydrological impact on the spatial distribution of invasive Eucalyptus trees along the Breede River, while his honours thesis evaluated ethnobotanical relationships around the Rio Tinto copper mine in Phalaborwa. Most recently he has worked as the Monitoring & Evaluation Project Manager for the City of Cape Town's invasive species unit. Gideon's consulting and project management expertise includes project management, EIA and EMPr applications, integrated water use licence applications, specialist botanical and ecological impact assessments, specialist wetland delineation and impact assessments, GIS applications and mapping. Gideon currently works from the Johannesburg office, and is interested in invasion ecology, treatment of groundwater pollution through phytoremediation, botanical and wetland specialist studies, GIS application for ecology and environmental management, and the EIA processes in general.

Dr A.M (Ted) Avis, Managing Director and Reviewer (Project Leader & EAP)
Ted Avis is a leading expert in the field of Environmental Impact Assessments and environmental management, having project-managed numerous large-scale ESIAs and ESMPs to International Finance Corporation Performance Standards. Ted has been EIA study leader on numerous large scale ESIA's and ESHIA's for projects with capital investments ranging from US$200m to over US$1billion. He has been study leader for ESIA and related environmental studies completed to international in, Egypt, Kenya, Liberia, Mozambique, Madagascar, Malawi Sierra Leone, South Africa and Zambia,. Ted also has experience in large scale Strategic Environmental Assessments in southern Africa, and has been engaged by the International Finance Corporation (IFC) on a number of projects.

Most of the ESIA work Ted has been involved in has included the preparation of various Environmental & Social Management Plans, Resettlement Action Plans and Monitoring Plans. These ESIA's cover a range of sectors including infrastructure, mining (heavy minerals, graphite, tin, copper, iron), agri-industrial, forestry, resorts and housing development, energy, ports and coastal developments.

Ted holds a PhD in Botany, and was awarded a bronze medal by the South African Association of Botanists for the best PhD adjudicated in that year, entitled “Coastal Dune Ecology and Management in the Eastern Cape”). He has delivered papers and published in the field of EIA, Strategic Environmental Assessment and Integrated Coastal Zone Management and has been a principal of CES since its inception in 1990, and Managing Director since 1998.

Ted was instrumental in establishing the Environmental Science Department at Rhodes University whilst a Senior lecturer in Botany, based on his experience running honours modules in EIA practice and environmental management. He was one of the first certified Environmental Assessment Practitioner in South Africa, gaining certification in April 2004. He has been a professional member of the South African Council for Natural Scientific Professionals since 1993.

SPECIALIST CHECKLIST

Section	*NEMA 2014 Regulations - Appendix 6(1) Requirement*	Position in report
1	A specialist report prepared in terms of these Regulations must contain—	-
(a)	details of-	-
	(i) the specialist who prepared the report; and	Page iii
	(ii) the expertise of that specialist to compile a specialist report including a curriculum vitae;	Appendix D
(b)	a declaration that the person is independent in a form as may be specified by the competent authority;	Attached
(c)	an indication of the scope of, and the purpose for which, the report was prepared;	Chapter 1
(d)	the date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 2.1
(e)	a description of the methodology adopted in preparing the report or carrying out the specialised process;	Section 4.2
(f)	the specific identified sensitivities of the site related to the activity and its associated structures and infrastructure;	Chapter 6
(g)	an identification of any areas to be avoided, including buffers;	Chapter 6 and Chapter 7
(h)	a map superimposing the activity including the associated structures and infrastructure on the environmental sensitive of the site including areas to be avoided, including buffers;	Chapter 6
(i)	a description of any assumptions made and any uncertainties or gaps in knowledge;	Section 4.4
(j)	a description of the findings and potential implications of such findings on the impact of the proposed activity, including identified alternatives on the environment;	Chapter 7
(k)	any mitigation measures for inclusion in the EMPr;	Chapter 7
(l)	any conditions for inclusion in the environmental authorization;	Chapter 7 and Chapter 8
(m)	any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Chapter 8
(n)	a reasoned opinion- (i) as to whether the proposed activity or portions thereof should be authorized and (ii) if the opinion is that the proposed activity of portion thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Chapter 7 & 8
(o)	a description of any consultation process that was undertaken during the course of preparing the specialist report;	Refer to Basic Assessment Report
(p)	a summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Refer to Basic Assessment Report
(q)	any other information requested by the competent authority.	None for the aquatic report

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

PLATES

LIST OF ABBREVIATIONS

ASPT	Average Score per Taxon
CBD	Convention on Biological Diversity
CDOM	Coloured Dissolved Organic Matter
CSIR	Council for Scientific and Industrial Research
DEA	Department of Environmental Affairs
DWS	Department of Water Affairs
EIA	Environmental Impact Assessment
EIS	Ecological importance and sensitivity
EMP	Environmental Management Plan (or Programme)
EMPr	Environmental Management Programme Report
EPT	Ephemeroptera, Plecoptera and Trichoptera
IFC	International Finance Corporation
IUCN	International Union for Conservation of Nature
NFEPA	National Freshwater Ecosystem Priority Areas
PES	Present Ecological State
SAIAB	South African Institute of Aquatic Biodiversity
SANAS	South African National Accreditation System
SANBI	South African National Biodiversity Institute
SANParks	South African National Parks
SASS5	South African Scoring System Version 5
SIC	Stones in current
SOOC	Stones out of current
USEPA	United States Environmental Protection Agency
USEPA	United States Environmental Protection Agency
WRC	Water Research Commission
WWF	Worldwide Fund for Nature

1 INTRODUCTION

1.1 Project description

The Wijnberg Farm Trust proposes to enlarge Dam 2 on Hugosdale Farm (RE/141), near Greyton in the Western Cape. The expansion of the dam will be done by constructing a new dam wall (>5m) that will inundate the existing dam and increase its surface area from 5 500m^2 to 65 500m^2, an increase of 60 000m^2. The overall dam capacity will increase from 56 965 m^3 to 500 000 m^3 (i.e. increase of 443 035 m^3).

The purpose of the proposed development is to increase the water availability on the farm for the irrigation of new deciduous fruit trees and cattle feed grass, as well as reduce electricity consumption by increasing gravity feed irrigation.

The following infrastructure will be required as part of the proposed activity:

- Dam wall;
- Spillway; and
- Laydown area.

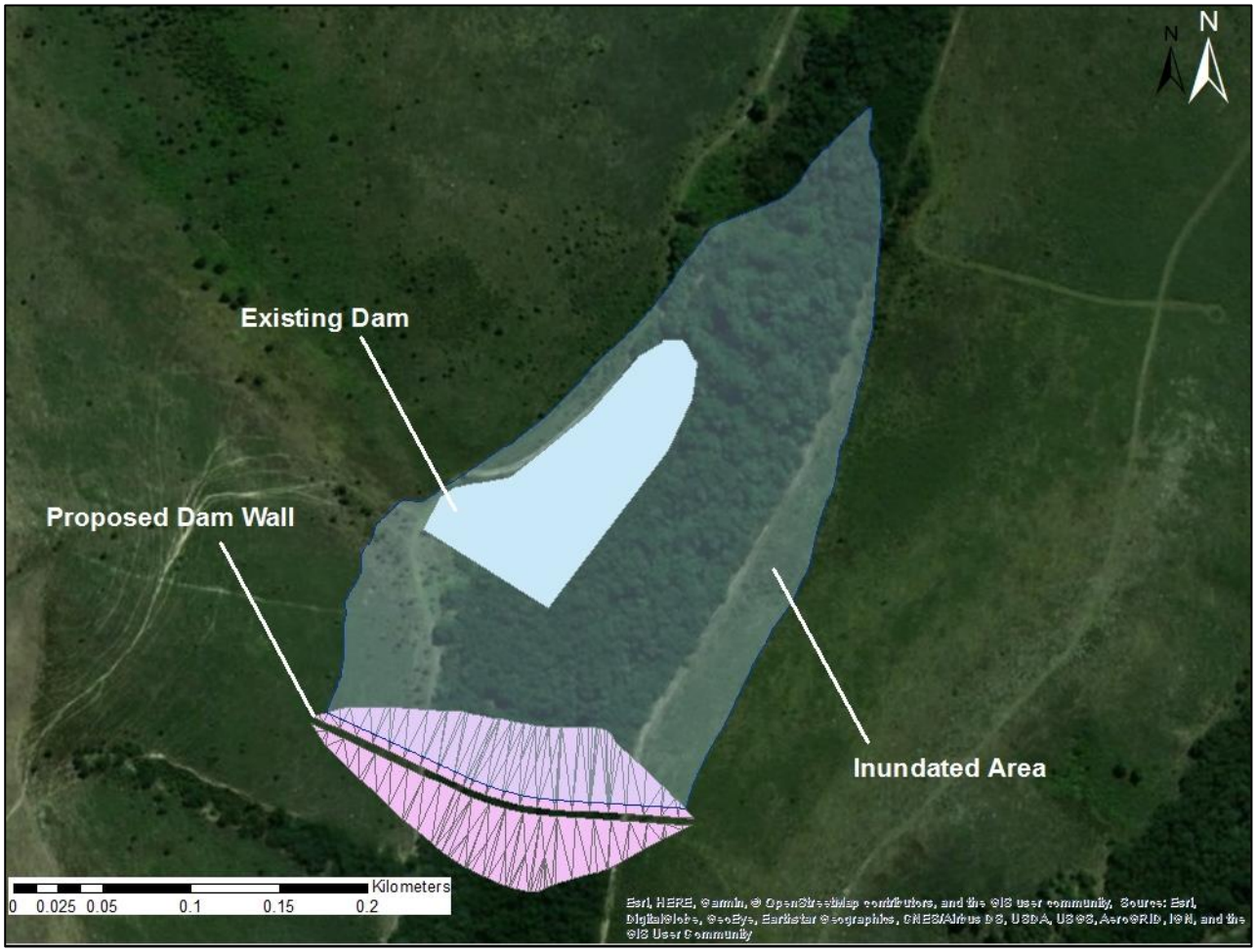


Figure 1.1. Change in surface area of Dam 2.

1.2 Locality

The project site is located on the Remaining Extent (RE) of Farm 141. Hugosdale Farm is located 5km south east of Greyton, along the R406 (Figure 1.2). This area is comprised primarily of farmland with the Riviersonderend Mountain range to the north.

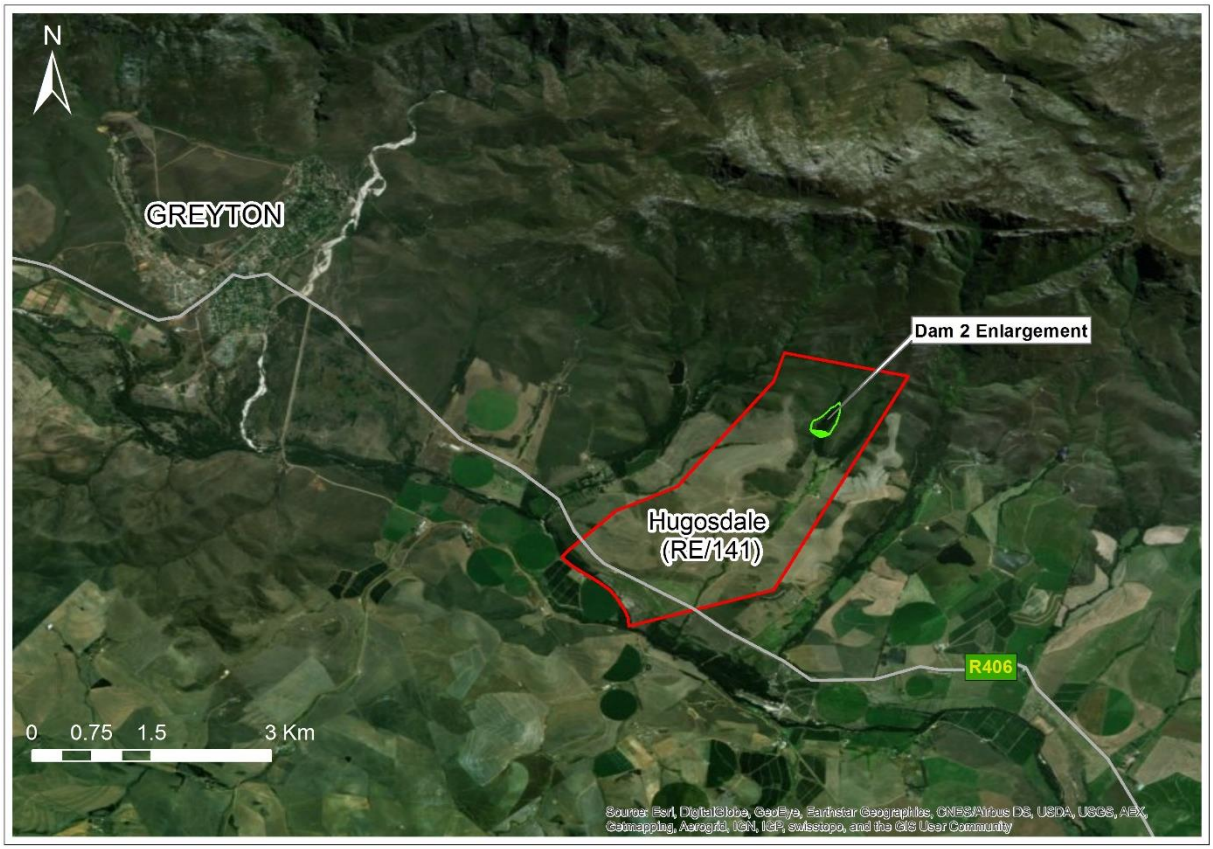


Figure 1.2. Locality Map showing the position of the Hugosdale Farm in relation to the town of Greyton.

1.3 Terms of Reference

The following terms of reference apply to this report:

- Establish the ecological baseline status and general health of the river adjacent to the existing Dam 2, in terms of invertebrate indicator species;
- Determine the ecological importance of the river system;
- Identify general upstream and downstream water use activities; and
- Determine the impacts and severity for the proposed Dam 2 expansion on riverine ecology.

The assessment of invertebrate composition was conducted to form a baseline from which to determine future impacts, and to inform the existing pollution levels and pollution sources likely to be present on site. No organic or chemical testing (physico-chemical properties) was deemed necessary at this stage.

1.3.1 Establish baseline status employing invertebrate indicator species composition:

The South African Scoring System version 5 (SASS5) is a biological index which determines the health of a river based on the presence, absence, quantity and composition of aquatic invertebrates found within different aquatic states (biotopes) within a given river reach. It is used in conjunction with the water quality indices such as ph, electrical conductivity, temperature and dissolved oxygen as a measure of water quality characteristics and ecosystem health. In short, the SASS method provides an overall estimate of the river health by evaluating invertebrate taxa found in the different biotopes of a site, and based on this a rating of the river health can be determined.

1.3.2 Determine the ecological importance of the river system.

The ecological importance of a river is an expression of its importance to the maintenance of biological diversity and ecological functioning on local and wider scales. Ecological sensitivity (or fragility) refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (resilience) (Resh *et al*. 1988). Both abiotic and biotic components of the system are taken into consideration in the assessment of ecological importance and sensitivity (EIS). As this report only covers the biotic component of the system, the moderate EIS rating is of LOW confidence. Table 1.1 indicates the EIS categories as defined by the South African Department of Water Affairs, and provides a general description of the type of system that would be considered to fall into each category.

Table 1.1. Ecological Importance and Sensitivity Categories.

Ecological Importance And Sensitivity Categories	General Description
Very high	River systems that are considered to be unique on a national or even 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.
High	River systems that are considered to be 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 in some cases, may have a substantial capacity for use.
Moderate	***River systems 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 usually not very sensitive to flow modifications and often have a substantial capacity for use.***
Low/marginal	River systems that are not unique at any scale. These rivers (in terms of biota and habitat) are generally not very sensitive to flow modifications and usually have a substantial capacity for use.

1.3.3 Identify upstream and downstream users.

Upstream and downstream activities were determined through scrutinising aerial imagery, as well as a confirmatory site visit during the data gathering for this report. The following activities were found:

Upstream

Near-pristine upper-reach river: The upstream area of Dam 2 lies immediately south of the Riviersonderend Mountains, and is comprised of steep mountainside terrain. The upstream area was impacted only by the historical clearance of vegetation (possibly as part of a fire break) on the foot slopes of the Riviersonderend Mountains, but was otherwise near-pristine in that only one access road was in place, and no other built up features were evident (Plate 1.1). However, a high diversity of invasive species was evident (Table 1.2). The following species in particular were located along either side of the river reach, throughout the length of the study site.

Table 1.2. List on invasive alien species found within the inundated area and surrounds.

Scientific Name	Common Name	NEMBA Status
Acacia mearnsii	Black Wattle	1b
Acacia longifolia	Long-Leaved Acacia	1b
Pinus cf pinaster	Pine Tree	1b
Hackea sericea	Silky Hakea	1b

Plate 1.1. View immediately upstream of Dam 2, showing the large quantities of *Acacia mearnsii* and *Acacia longifolia* present along the watercourses.

Dam 2

Dam 2 is the dam under investigation, which is located in the central portion of the study area. The dam is currently served by one canalised inflow – sourced from the unnamed stream running immediately towards the east of the dam, and thus does not form part of the river channel itself, but rather relies on the offtake water from that stream to sustain its levels (Plate 1.2). Furthermore, outflow from the dam is via an overflow at the northernmost tip of the dam (Plate 1.3), which then flows into a natural channel and reconnects with the adjacent stream roughly 20m southwards of the outflow (Figure 1.3).

Plate 1.2. Inflow canal into Dam 2, view towards the south.

Figure 1.3. Inflow and outflows, along with the adjacent stream to Dam 2.

Plate 1.3. Dam 2 looking towards the east, showing the stone dam wall towards the south and the invasive species located along the boundary.

Downstream

Downstream activities from the site consisted entirely of agricultural activities, including grazing for cattle (immediately downstream), and the planting of orchards (Plate 1.4). Buildings related to farming activities, as well as a few labourer homesteads, are located along the adjacent river channel (distinct from the channel investigated in this report). Water use on the farm includes minor use of the river for clothes washing and other domestic use, as well as irrigation of the orchards and watering of cattle. The entire property containing this section of the study site operates as a farm, and thus mainly farming impacts are considered applicable to the water quality of the river.

Plate 1.4. Downstream view of the project site, showing fields used for grazing of cattle.

1.3.4 Determine the impacts and severity for the proposed Dam 2 expansion

The determination of impacts for the proposed Dam 2 expansion works has been included in chapter 7 of this report, in accordance with a recognised and widely employed methodology. Please refer to chapter 7 of this report for detailed evaluation of the impacts, as well as Appendix B for an explanation of the assessment methodology employed.

2 LEGISLATION, POLICY AND GUIDELINES

2.1 Regulatory Requirements

A detailed legal assessment is discussed in the main Environmental Impact Assessment and Environmental Management Programme report (EIA/EMP).

The Acts and Regulations that pertain to the surface water include:

- The Constitution of the Republic of South Africa (Act 108 of 1996).
- The National Water Act, Act 36 of 1998 (hereafter referred to as NWA).
- The National Environmental Management Act, Act 107 of 1998 (hereafter referred to as NEMA).
- National Environmental Management: Waste Act, 2008 (Act 59 of 2008) (NEM:WA).
- The Environmental Conservation Act, Act 73 of 1989 (hereafter referred to as ECA).
- Government Notice (GN) 704 of 4 June 1999: Regulation on use of water for mining and related activities aimed at the protection of water resources (hereafter referred to as GNR704).
- Government Notice (GN) R139 of 24 February 2012: Regulations regarding the safety of dams in terms of Section 123(1) of the NWA
- Government Notice (GN) R991 of 18 May 1984: Requirements for the purification of waste water or effluent.
- Government Notice (GN) R398 and 399 of March 2004: General Authorisations in terms of the NWA.
- Government Notice (GN) R543 to 546 of June 2010: Listed activities in terms of NEMA.
- Government Notice (GN) R636 of August 2013: National norms and standards for disposal of waste to landfill, in terms of NEM:WA.

2.2 National Legislation

National legislation applicable to surface water management includes:

- Constitution of the Republic of South Africa (Act No. 108 of 1996) – The Bill of Rights states that everyone has the right to an environment that is not harmful to their health or well-being.
- National Water Act (Act No. 36 of 1998) – Provides for the protection of the quality of water and water resources in South Africa and provides for the establishment of Water Management Areas to be managed by Catchment Management Agency's.
- Water Services Act (Act No.108 of 1997) – Provides for the regulation of water boards and the setting of national water quality standards.
- National Environment Management: Waste Management Act (Act No. 59 of 2008) – Provides for the regulation of waste and the prevention of pollution from the waste generated at a specific site.
- Minerals Petroleum Resources Act (Act No. 28 of 2008) - provides for the implementation of pollution control and waste management measure.
- National Environmental Management Act (Act No. 107 of 1998) – This Act provides for access of every person to state-held information on emissions to water sources and ensures that Department of Water and Sanitation (DWS) and its representatives are fundamental to any activity governed by the NEMA legislation.
- Promotion of Access to Information Act (Act No. 2 of 2000) – Gives effect to the constitutional right to access information held by the state, such as information one missions to water sources.

2.3 National Policy/Guidelines

National policy and guidelines applicable to surface water management includes:

- South African Water Quality Guidelines, First Edition, 1996 – These guidelines set out the minimum water quality requirements for a range of water quality parameters for each water user.
- Guide to conduct Water Quality Catchment Assessment Studies: In support of the Water Quality Management Component of a Catchment Management Strategy. Sub-Series 8.3, 2003 – Guide to standardised collection, processing and presentation of data for effective catchment and water quality management.
- A Conceptual Introduction to the Nature and Content of the Water Quality Management and Assessment Components of a Catchment Management Strategy. Sub-Series 8.1, 2003 – Outlines the concepts and nature of a Catchment Management Strategy with an emphasis on water quality management.
- A Guideline to the Water Quality Management Component of a Catchment Management Strategy. Sub-Series 8.2, 2003 - Sets out guidelines and the framework for integrating the management of water quality into catchment water resource management.
- Aide Memoire for the preparation of a water quality report to support the application for licenses for sewage purification works in terms of the requirement of the NWA – Assists local authorities and owners of sewage treatment works to apply for a licence.

3 BIOPHYSICAL DESCRIPTION

3.1 Physical Environment

3.1.1 Climate

Greyton has a warm and temperate climate (Figure 3.1) and falls within a winter rainfall area with an average annual rainfall of 490mm. The average annual temperature is 16.6ºC with the warmest months occurring in January and February and the coolest month in July (SAexplorer, 2018).

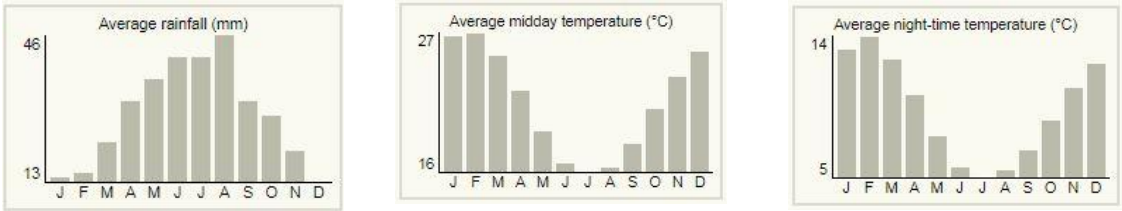


Figure 3.1. Average rainfall and temperature variation over a 12 month period throughout the proposed project area.

3.1.2 Topography

The dam is located in the foothills of the Riviersonderend mountain range (Figure 3.2), in a valley that slopes down towards the stream and current dam site. The hills on either side of the proposed dam are gentle to moderate and the altitudinal range between the highest immediate slope and the stream bed is approximately 60-70m.

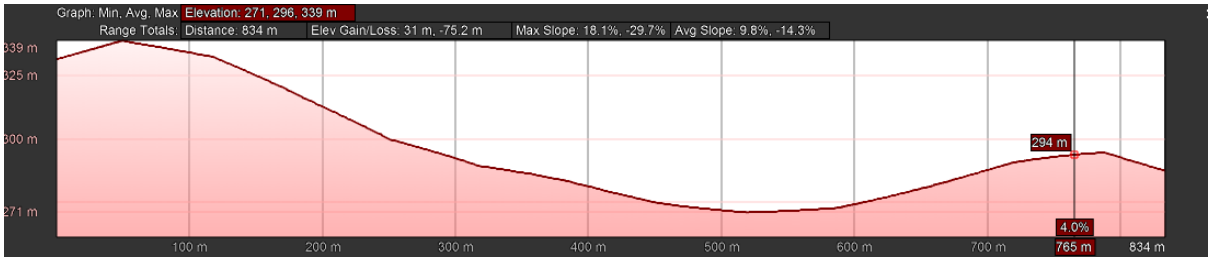


Figure 3.2. Elevation profile of the proposed site. The highest point to the west is 339m asl and the lowest point, where the dam will be located, is 271m asl.

3.1.3 Hydrology

The general hydrology of the broader area comprises mainly of man-made farm dams and wetlands formed by prolonged periods of inundation along the various mountain streams formed in the Riviersonderend Mountain Range. All the streams located towards the south of the Riviersonderend Mountain Range drain into the Riviersonderend River, further forming part of the Breede River catchment which terminates at the town of Witsand in the Western Cape. Numerous National Freshwater Ecosystem Protection Areas (NFEPA) rivers and wetlands are found within the area.

NFEPA was a three-year partnership project between South African National Biodiversity Institute (SANBI), CSIR, Water Research Commission (WRC), Department of Environmental Affairs (DEA), Department of Water Affairs (DWA), Worldwide Fund for Nature (WWF), South African Institute of Aquatic Biodiversity (SAIAB) and South African National Parks (SANParks). NFEPA map products provide strategic spatial priorities for conserving South Africa's freshwater ecosystems and supporting sustainable use of water resources. These strategic spatial priorities are known as Freshwater Ecosystem Priority Areas, or FEPAs. FEPAs were determined through a process of systematic biodiversity planning and involved collaboration of over 100 freshwater researchers and practitioners. FEPAs were identified based on a range of criteria dealing with the maintenance of key ecological processes and the conservation of ecosystem types and species associated with rivers, wetlands and estuaries (Implementation Manual for Freshwater Ecosystem Priority Areas, 2011).

According to the NFEPA wetland inventory, numerous wetlands occur in the broader region of the project site (Figure 3.3). The study area itself is bounded to the north by the Gobos River, to the south by the Riviersonderend River, and to the east by the Soetmelksvlei River (Figure 3.3).

No NFEPA rivers were found to occur within the project site, or to be within 100m of site. Dam 2 is located within a NFEPA wetland, classified as a natural, valley-floor wetland with a wetland condition of C, indicating moderate modification.

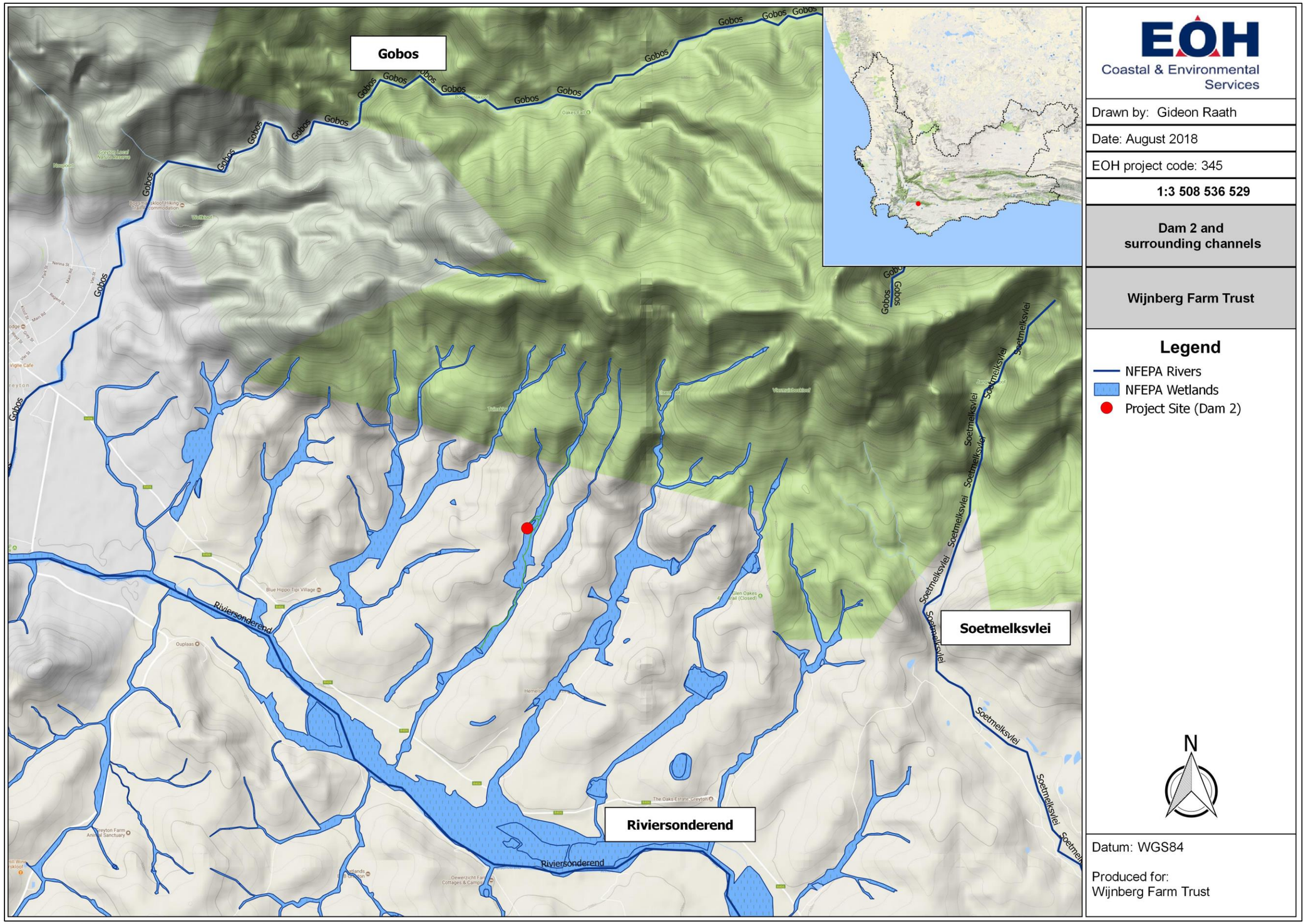


Figure 3.3. NFEPA Rivers and wetland within the project region.

3.1.4 Land use

The farm is currently used to graze cattle and has some fruit orchards in the southern region, near the access road. The area where the dam will be situated is in a near natural state along the hill slopes and completely transformed by invasive alien species in the stream bed. Only cattle grazing occurs in this area.

3.2 Ecosystem services

From a socio-economic perspective ecosystems provide resources required for material welfare and livelihoods and provide health and cultural benefits to the people who use them. These functions are considered to be ecosystem services, which the IFC (PS6, 2012) define as "the benefits that people, including businesses, obtain from ecosystems".

Ecosystem services represent the benefits that humans obtain from ecosystems. These services are both direct and indirect in nature, some easily recognised and others more subtle. Human well-being is fundamentally dependent upon all these services. Changes in these services can affect humanity, sometimes dramatically, with negative impacts on security, basic materials for human health and well-being, and the maintenance of social and cultural relations.

Ecosystem services have been divided into four categories (UNEP, 2009).

- *Provisioning services* include products or goods obtained from ecosystems such as fresh water, foods and timber;
- *Regulating services* include ecosystem functions such as flood control and climate regulation;
- *Cultural services* include non-material benefits such as recreation (sport, hunting, fishing), , spiritual, religious and aesthetic uses, cultural heritage, and a "sense of place"; and
- *Supporting services* include fundamental processes such as nutrient cycling and primary production in support of the above three categories.

River ecosystems provide numerous ecological and societal goods and services (Costanza *et al*. 1997). Ecosystems that are in a natural state offer more services and retain more functionality than systems that are anthropogenically impacted. The moderately modified state of the rivers in the area implies that the functionality of the aquatic ecosystem is still considerable, and that the mainstem river and associated riparian zone, flood plains, wetlands and tributaries are likely to provide a moderate degree of services and functions. The potential ecosystem services provided by the aquatic environment are listed in Table 3.1.

Table 3.1. Ecosystem services provided by river ecosystems

Ecosystem Services	Ecosystem Functions	Specific Functions
Regulation of Disturbance/ Ecosystem Resilience	Regulation of episodic and large environmental fluctuations	Flood control, drought recovery
Water supply and Regulation/ Hydrological conveyance/ Water quality regulation	Supply and regulation of water flow, water quantity and quality	Provision of water for ecosystem services, agricultural and house hold use in sufficient quantity and quality
Sediment Supply and Regulation	Regulation of sediment supply to downstream	Maintenance geomorphological features such as sand bars and sand banks
Erosion Control	Retention of soil within an ecosystem	Prevention of soil loss by riparian vegetation cover and soil retention
Soil formation	Soil formation processes	Weathering of rock by water and accumulation of organic material in rivers.
Nutrient cycling	Storage, recycling, capture and processing of nutrients	Nitrogen fixation and nitrogen cycling through intact aquatic food chains
Waste treatment	Recovery of nutrients, removal and breakdown of excess nutrients	Breaking down of waste, detoxifying pollution

Ecosystem Services	Ecosystem Functions	Specific Functions
Regulation of food web dynamics / Biological control	Regulation of animal and plant populations	Top/down control. Predator control of prey species, maintain population balance
Refugia	Habitat for resident and migratory populations	Nurseries, habitat for migratory fish and birds, regional habitats for species, habitat for sensitive and rare species.
Food production	Primary production for raw materials	Production of fish and plants for local consumption
Raw Materials	Primary production for raw materials	Production of craftwork materials, house building materials and fodder
Maintenance of genetic resources	Unique biological materials and products	Gene flow
Cultural	Providing opportunities for non-commercial uses	Aesthetic, spiritual, intrinsic and scientific values of ecosystems
Carbon Flux Regulation	Regulation of chemical composition of the atmosphere	Carbon sequestration, oxygen and ozone production
Maintenance of longitudinal and lateral connectivity	Provision of migratory connectivity for aquatic and terrestrial species	Maintenance of aquatic and terrestrial biodiversity

Any alteration to the morphology, hydrology and hydraulic regime of a river system can result in changes to the quality of the ecosystem services indicated in Table 3.1. Although the most obvious impact is noticed at a local scale, the extent of the impact will not remain localised, but will be felt as a gradient of impacts along the length of the system.

The degree to which potential changes will impact on ecosystem services will depend on both the nature of the impact and the nature of the receiving watercourse, making the quantification of ecosystem services losses particularly difficult.

4 METHODOLOGY

4.1 Aims and objectives

The aims of the site visit were:

- To get a clear understanding of the connections between the river systems on site.
- To obtain data on the invertebrate composition of the river directly above and below the dam;
- To use the invertebrate data to evaluate the current condition of the river within the system;
- To determine the impacts associated with the expansion of the dam and the likely severity thereof on the existing river.

The information obtained during the site visit was then used to address aspects of the Terms of Reference set out in section 1.1 above.

4.2 Sample Sites

The proposed project area was visited in the wet season, for one day only on the 31st of July, 2018. Initially the general area was surveyed using Google Earth™ imagery in order to gauge the most appropriate sample sites. The accessibility of the various sites was examined during the site visit and the exact location of the sample sites was determined. Please refer to chapter 5 for detailed information on the sample sites.

4.3 Aquatic Invertebrates

Although chemical measures are important components of aquatic impact assessments (Adams 2005), whereby measuring the environmental concentrations of a chemical can give an indication of the spatial extent of contamination, the environmental concentration measured only reflects the level of the chemical at the time of sampling. The continuous exposure concentration is not known, and thus an accurate assessment of the effect of the chemical on aquatic organisms cannot be determined. Furthermore, although chemical data can indicate which variable has the potential to cause an environmental impact, this is only possible for the chemical variables chosen for analysis in the laboratory. The potential effects of unmeasured variables are unknown.

The biomonitoring of aquatic organisms has the advantage of providing a time-integrated indication of responses to the temporally variable concentrations of potential stressors (Karr and Chu 2000). In addition, biological response data provide an integrated indication of the effects of the many potential physical, biological and chemical stressors that coexist in aquatic ecosystems and that might not have been measured as part of the water sampling programme (Adams 2005). Using biological responses could, therefore, identify environmental impacts that might be missed or underestimated were the chemical data alone used (Adams 2005). Lastly, the impact of a chemical stressor on an organism is governed only by the bioavailable fraction of its total concentration. Environmental factors (e.g. high organic carbon and pH) and biotransformation processes within an organism's body can reduce the bioavailability of metals and organic stressors.

Protection of aquatic ecosystem structure and function is the usual goal of environmental water resource management. Macroinvertebrate community structure, measured as taxonomic richness and diversity, has been the approach most readily investigated and applied (Peru and Doledec 2010). Rapid biotic indices based on the relative tolerances of macroinvertebrates to water quality degradation have also been developed, but tend to be geographically specific. The South African Scoring System (SASS) version 5 (Dickens and Graham 2002) is such an index, and is the most popular macroinvertebrate rapid bioassessment tool in use in South Africa.

4.3.1 Sample collection

Samples were collected from all available biotopes (stones in and out of current, aquatic vegetation, marginal vegetation, gravel, sand and mud) using the standard South African Scoring System Version 5 (SASS5) method. The SASS5 collection method is fully described in Dickens and Graham, 2002, and has been specifically designed to comply with international accreditation protocols of this nature.

The SASS5 method incorporates all available biotopes at a site, and provides an indication of the integrity of the macro-invertebrate community by recording the presence of macro-invertebrate families at the site. Each taxon is allocated a score based on its level of tolerance to the overall health of the river system (Dickens and Graham, 2002).

In an attempt to capture all macro-invertebrate families present at a site, samples were taken within each available biotope. The individual samples were then pooled and classed as a single sample for the purpose of identification.

4.3.2 Identification

After sampling the various biotopes, the contents of the sample net was emptied onto a tray. All visible invertebrates were picked from a tray and picking continued until no new individual was picked for the prescribed period. Easily identifiable species were recorded on the SASS datasheet and returned to the water. Species which required more time to identify were transferred into a jar containing 70% ethanol and identified on site. Various field guides and taxonomic keys were utilized to identify the macro-invertebrates within each sample to family level.

4.3.3 Assessment of Present Ecological State

Very little information is available regarding the invertebrate diversity within the project area. This lack of data makes it difficult to compile a “reference state” against which to assess the present ecological state of the rivers. As such, it is proposed that the baseline monitoring provide the “reference state” against which all subsequent biomonitoring be assessed. The South African Ecological Reserve Determination process has defined default benchmark categories for use in classifying the quality of the aquatic ecology, as indicated in Table 4.1.

An assessment of the Present Ecological State (PES) was conducted using SASS. Each taxon identified contributed to the overall SASS score for the site. This score was then divided by the number of taxon found at the site which provided the average score per taxon (ASPT). The ASPT score is used to determine the PES by classifying the quality of the aquatic ecology according to the benchmark categories as indicated in the table below.

Table 4.1. The default benchmark category boundaries for the SASS.

Class boundary	Range of ASPT Scores
Natural	7
Good	6
Fair	5
Poor	<5

4.3.4 Qualitative assessment of biotic integrity based on Ephemeroptera, Plecoptera and Trichoptera taxa richness

The United States Environmental Protection Agency (USEPA) approach to the qualitative assessment of the biotic integrity of a stream was applied to the sample sites. The objective of the *Ephemeroptera, Plecoptera and Trichoptera* (EPT) Taxa Richness Metric is to provide a baseline for future rapid bioassessments. The EPT taxa are considered to be sensitive to pollution (Barbour *et*

al, 1999), and as such the level of degradation at a site can be determined by assessing the presence of Ephemeroptera (Mayflies), Trichoptera (Caddisflies) and Plecoptera (Stoneflies) taxa. The number of EPT taxa found at each site is calculated as a percentage of the total number of taxa found for that site. A high EPT taxa richness would indicate little or no degradation, while a low EPT taxa richness would indicate a high level of site degradation.

4.4 Assumptions and Limitations

i. Data on aquatic species in smaller, outlying systems such as this are not commonly available. It was therefore necessary to assume that a number of species of special concern, rare and endangered species, and undescribed species possibly occur within the study area.

5 DESCRIPTION OF SAMPLE SITES

Invertebrate samples were taken at three sites respectively located upstream, midstream and downstream of Dam 2. One sample was collected approximately 450m upstream of Dam 2, whilst the midstream sample was collected approximately 50m below the outlet from the dam. Sample site three was located approximately 500m downstream of the dam. Figure 5.1 shows these locations and a summary is provided in Table 5.1.

Table 5.1. Co-ordinates and site names for sample sites.

Site Number	Site Name	Co-ordinates		Test
		South	East	
S1	S1 - Upstream	34° 3'50.23"S	19°40'33.02"E	SASS Sample; Pictures
S2	S2 - Midstream	34° 4'3.12"S	19°40'27.06"E	SASS Sample; Pictures
S3	S3 – Downstream	34° 4'16.99"S	19°40'21.93"E	SASS Sample; Pictures

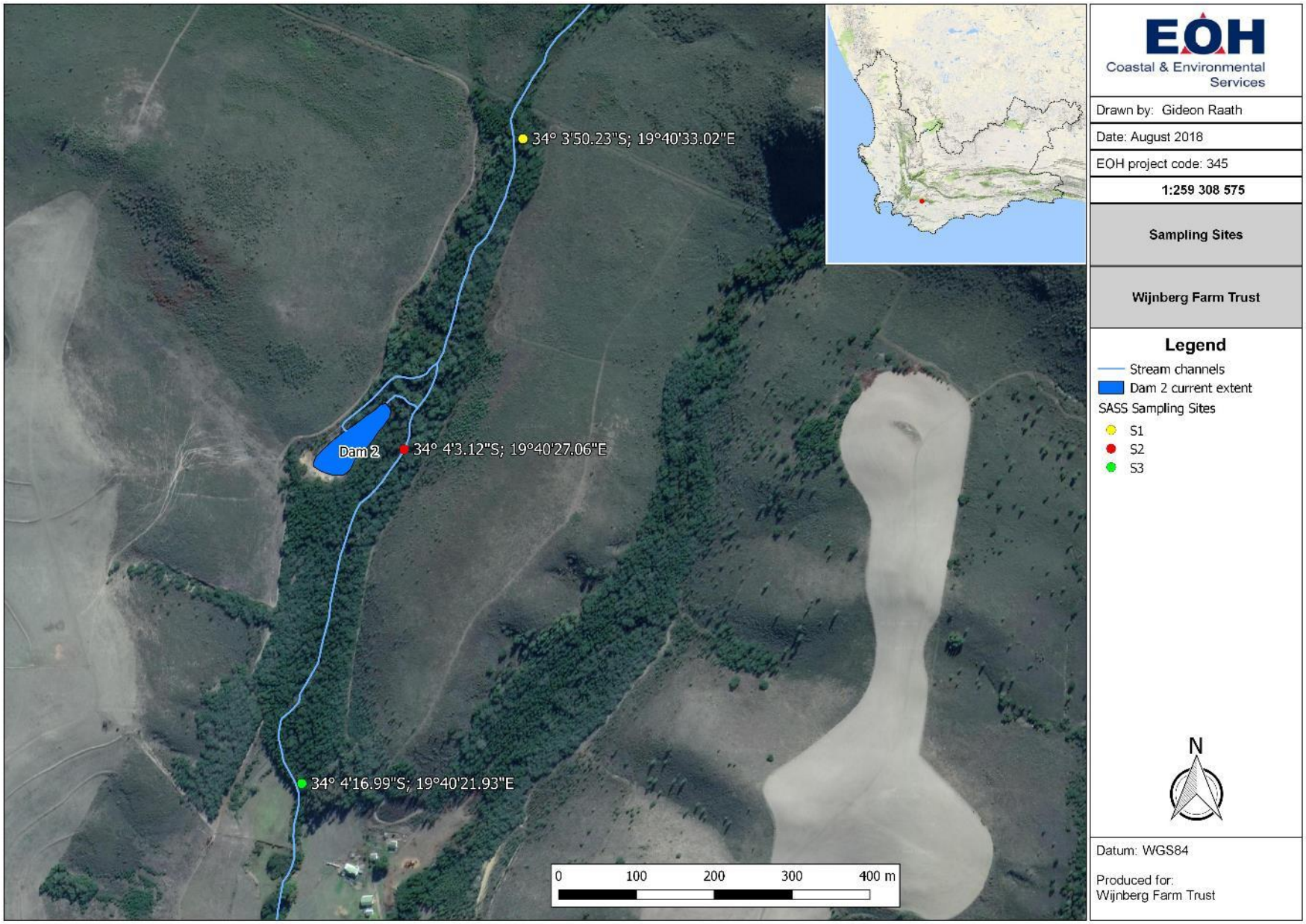


Figure 5.1. Sampling site locations along the stream running past Dam 2.

5.1 Site S1 (upstream)

This site was located approximately 450m northwards of Dam 2, and was fed with a small mountain stream approximately 1m wide (Plate 5.1). The water had no discernible smell, oily or soapy residue or visible pollution, was very clear and fast flowing. At this site, the aquatic vegetation biotope was underrepresented and not readily available. This site was located in a moderately dense forest of invasive Acacia species, overshadowing the stream almost entirely, which may alter invertebrate species composition locally. Regardless, the source of the stream was approximately 2km upstream from that point, on a steep mountainside, and no visible anthropogenic impact was observed between the source and the sampling site.

Plate 5.1. Site S1, looking upstream towards the north.

5.2 Site S2 (midstream)

This site was located approximately 50m downstream of the dam outlet, and was characterised by dense invasive Acacia tree growth along both sides of the stream, with a small (1.5m) wide channel with plenty of large boulders in the channel (Plate 5.2). The water had no discernible smell, but a slight foam layer was visible on the surface in places. Water here also had a greater degree of sediment load, in particular a 'sticky' brown Coloured Dissolved Organic Matter (CDOM) clinging to all vegetation and rock surfaces, along with fine silt load being overrepresented in the water column. The CDOM mentioned also gave the water a fairly strong tea colour, contributing to reduced clarity and a greater measure of turbidity. The CDOM found here likely originated with the ongoing clearing action of invasive species near Dam 2, with felled trees allowing to decay along the stream and subsequently introducing larger volumes of decaying organic matter into the stream than would have occurred without intervention.

Plate 5.2. Midstream sampling site (S2), with the visible foam layer and dark coloured pigmentation visible.

5.3 Site S3 (downstream)

This site was located approximately 500m downstream of the Dam 2 outlet, and was characterised by steep (3m) high channel walls, adjacent to a large open field used for grazing (Plate 5.3). Cattle disturbance could be noted further downstream where the water was more accessible. This site, as with the two previous sites, were highly invaded with invasive *Acacia* species, with an almost closed canopy over the river channel and moderate quantities of leaf litter, roots and decaying material introduced into the stream. Regardless, at this site there was no smell or distinctive colour to the water, with slightly less tea coloured pigment noted in the water. The CDOM present at the previous

site was significantly reduced and the water was clearer in comparison.

Plate 5.3. Site S3 (downstream) sampling site showing the high degree of overshadowing and invasive species growth adjacent to the river channel.

6 RESULTS

6.1 Aquatic Invertebrates

A total of 32 aquatic macro-invertebrate taxa (from 11 different families) were found within the sampled river (Table 6.1). The number of aquatic macroinvertebrate taxa sampled ranged from 11 at the midstream site (S2), to 22 found at the upstream site (S1), which reflected an overall highly diverse community of invertebrates within the stream. Please refer to Appendix A for complete datasheets for these sites.

Table 6.1. List of aquatic invertebrate families identified at each site as well as indicating their sensitivity.

		BIOTOPE			
INVERTEBRATE	**Score**	**Stones**	**Vegetation**	**GSM**	**TOTAL**
S1 – Upstream					
ANNELIDA					
Oligochaeta	1	A	-	A	A
CRUSTACEA					
Amphipoda	13	B	A	B	B
HYDRACARINA (Mites)					
Hydracarina	8	-	-	1	1
EPHEMEROPTERA					
Baetidae 2 sp.	6	B	A	B	B
HEMIPTERA (Bugs)					
Hydrometridae	6	-	1	-	1
Veliidae	5	1	1	-	A
TRICHOPTERA					
Ecnomidae	8	1	-	A	A
Hydropsychidae 1 sp.	4	-	1	A	A
Hydropsychidae 2 sp.	6	A	-	-	A
Philopotamidae	10	1	1	A	A
Glossosomatidae*	11	A	-	-	A
Leptoceridae	6	-	-	A	A
Sericostomatidae	13	A	B	A	B
COLEOPTERA (Beetles)					
Dytiscidae	5	A	-	1	A
Elmidae	8	1	-	-	1
Helodidae	12	-	-	A	A
Hydraenidae	8	1	1	A	A
DIPTERA					
Athericidae	10	-	-	A	A
Ceratopogonidae	5	-	1	-	A
Chironomidae	2	A	-	-	A
Simuliidae	5	1	-	A	A
Tabanidae	5	A	-	1	A
SASS Score		118	70	110	**157**
No. of taxa		15	9	15	**22**
ASPT		7.8	7.7	7.3	**7.1**
S2 – Midstream					
INVERTEBRATE	**Score**	**Stones**	**Vegetation**	**GSM**	**TOTAL**
CRUSTACEA					
Amphipoda	13	-	1	-	1

		BIOTOPE			
INVERTEBRATE	**Score**	**Stones**	**Vegetation**	**GSM**	**TOTAL**
EPHEMEROPTER					
Baetidae 2 sp.	6	B	B	B	B
ODONATA					
Libellulidae	4	A	1	A	A
HEMIPTERA					
Corixidae	3	-	1	-	1
Nepidae	3	-	1*	-	1
Notonectidae	3	-	1	-	1
TRICHOPTERA					
Hydropsychidae 1 sp	4	-	1	1	A
COLEOPTERA (Beetles)					
Hydraenidae	8	-	B	-	B
DIPTERA					
Ceratopogonidae	5	-	A	-	A
Chironomidae	2	1	-	A	B
GASTROPODA					
Lymnaeidae	3	A	-	-	A
SASS Score		15	49	16	**54**
No. of taxa		4	9	4	**11**
ASPT		3.75	5.4	4	**4.9**
S3 – Downstream					
INVERTEBRATE	**Score**	**Stones**	**Vegetation**	**GSM**	**TOTAL**
ANNELIDA					
Oligochaeta	1	B	-	B	B
PORIFERA					
Porifera*	5	A	-	-	A
CRUSTACEA					
Amphipoda	13	A	-	1	A
EPHEMEROPTERA					
Baetidae 1sp.	4	-	A	-	A
Baetidae 2 sp.	6	B	-	A	B
Leptophlebiidae	9	-	-	1	1
Tricorythidae	9	A	-	-	A
ODONATA					
Libellulidae	4	-	-	A	A
HEMIPTERA (Bugs)					
Corixidae	3	-	-	B	B
TRICHOPTERA					
Ecnomidae	8	A	-	-	A
Hydropsychidae 1 sp.	4	A	-	-	A
Philopotamidae	10	-	-	1	1
Leptoceridae	6	B	-	B	B
COLEOPTERA (Beetles)					
Elmidae	8	1	-	-	1
Hydrophilidae	5	1	-	-	1
DIPTERA					
Athericidae	10	B	-	-	B
Ceratopogonidae	5	A	-	A	B
Chironomidae	2	B	A	B	B

		BIOTOPE			
INVERTEBRATE	**Score**	**Stones**	**Vegetation**	**GSM**	**TOTAL**
GASTROPODA					
Lymnaeidae	3	A	-	-	A
SASS Score		85	6	59	**115**
No. of taxa		14	2	10	**19**
ASPT		6.0	3	5.9	**6.0**

*Hand-Picking or visual observation based on the closest associated biotope.

Results from table 6.1 above show a wide variety of taxa found within this one stream, which is generally indicative of a well-functioning ecosystem with minor pressures influencing the system. This accords with the location of the stream, being located along a fairly inaccessible and fairly isolated area, with little to no anthropogenic impacts currently being experienced by this stream. In addition, the close proximity of the sample sites to the source of the river implies that good quality water received directly from the source has had little exposure to pollution sources or impacts at the sampling points, and is thus still expected to be good quality.

The results further indicate a distinct reduction in number of taxa and sensitive taxa noted for the two sampling sites below Dam 2 (site S2 and S3). In particular, the high turbidity and the strong pigmentation of the water at site S2, immediately below Dam 2 suggests that the ponding of water, and the subsequent hydrological impacts from the outflow of Dam 2 water back into the stream, has altered the water quality downstream of Dam 2 slightly. This may be due to the ongoing clearing action of invasive species along the bank, with large amounts of vegetation and debris having been introduced into the river and along the riverbanks, thus introducing a high nutrient load into the stream.

However, as the results from site 3 (S3) indicates a large recovery (as compared to site S2), this effect may be the result of less taxa being recorded due to the poor visibility of water at site S2, or alternatively might indicate that any pollutant or water quality impact experienced immediately below Dam 2 may be greatly reduced at site S3, through biological or other action experienced between the two sites. The latter is more likely due to the greater water clarity and reduced turbidity of site S3, as compared to site S2 immediately below Dam 2.

6.1.1 Sensitivity Comparison

In order to rank the importance of specific taxa within a community in a way that expresses the sensitivity of a community to pollution and/or habitat degradation, the SASS5 incorporates a scale of 1 to 15. Broadly, the scale can be broken down as follows:

- 1 – 5: Invertebrates which are highly tolerant to pollution
- 6 – 10:Invertebrates which are Moderately tolerant to pollution
- 11 – 15:Invertebrates which have a Very low tolerance to pollution.

Table 6.1 indicates the sensitivity “spread” across the sample sites using these colours.

Based on the sensitivity scoring, only one sensitive taxa - *Amphipoda* (*Crustacea*) - was found at sites S2 and S3, collectively representing the sites influenced by flow modification due to the presence of the dam. In contrast, site S1 upstream of Dam 2 displayed four sensitive taxa, namely *Glossosomatidae*, *Sericostomatidae*, *Helodidae* and *Amphipoda*, indicating very good ecosystem and water quality upstream of the dam. These results indicate that Dam 2 does reduce the water quality downstream of the dam to a minor degree, with flow regimes being altered by periodic water releases from the dam (via the piped outlet), as well as trapping silt and sediment and concentrating it around the Dam (nearest site S2). Regardless, the overall sensitivity scores for site S3 indicate that this effect may be vastly reduced further downstream, as evidenced by much improved results

from the S3 sample.

Furthermore, as discussed in section 4.3.4, the *Ephemeroptera, Plecoptera and Trichoptera* (EPT) Taxa Richness Metric may be used to indicate the level of degradation of a site. The EPT richness scores for each site are given provided in table 6.2.

Table 6.2. EPT richness of each site

Sample Site	# of taxa	# of EPT taxa	EPT richness (%)
Site S1	22	9	40
Site S2	11	3	27
Site S3	19	8	42

EPT scores are a percentage value of the presentation of EPT taxa within a given sample. Higher values indicate better water quality. While no known baseline EPT values are available for comparison for this particular stream, scores of greater than 28 are regarded as excellent, whilst scores of 20-28 are regarded as good in other studies conducted (Watershed Science Institute, 2012). Comparing literate results to the results above, indicate 'Good' to 'Excellent' EPT scores and provided further support for of the overall good water and ecosystem quality within this system.

6.1.2 Present Ecological State (PES)

In terms of the SASS methodology three principal indices are calculated, namely the SASS Score, the Number of taxa, and the Average Score per Taxon (ASPT). By dividing the SASS Score with the Number of taxa identified, the ASPT is calculated. The ASPT score is then used to define the Present Ecological State (PES) (refer to Section 4.3.3). The PES scores for each of the sites are provided below, using the Southern Coastal Belt (lower) ecoregion categories (Table 6.3).

Table 6.3. SASS score, Average Score Per Taxon and Present Ecological State of the rivers sampled.

Metric	Site S1	Site S2	Site S3
SASS score	157	54	115
no. of taxa	22	11	19
ASPT	7.1	4.9	6.0
PES Category	**A**	**D**	**B**
PES Name	Natural	Poor	Good
PES Description	Unmodified natural	Largely modified	Largely natural with few modifications

The PES results further support the sharp decline in quality between the S1 and S2 sites, as well, as indicating that the modification and impacts are largely removed at site S3, indicating natural biological action and functioning remains mostly intact further south of Dam 2.

Figure 6.1 below illustrates the overall site sensitivity, based on the above-mentioned PES categories.

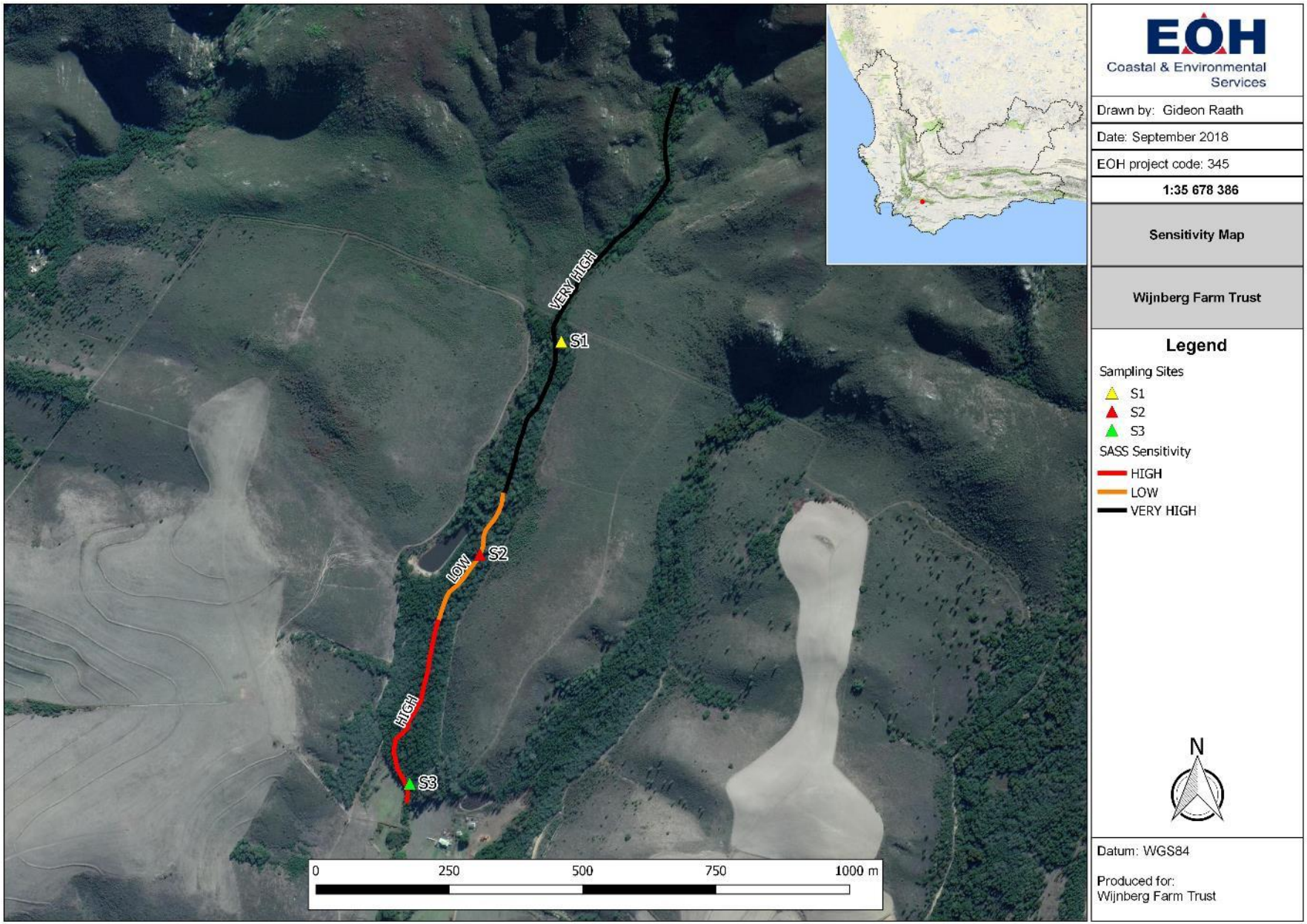


Figure 6.1. Aquatic sensitivity based on the SASS5 PES categories for the three sampling site.

7 ASSESSMENT OF POTENTIAL ENVIRONMENTAL IMPACTS

This chapter deals with aquatic ecology-related issues and impacts that were identified as a result of the project. The impact rating scales used for the assessment can be found in Appendix B.

7.1 Current state of the environment

The site is currently only impacted in the following manner:

i. Dam 2 represents a hydrological impoundment, altering the fine sediment load in the stream and the hydrological regime via intermittent water releases and offtake of water to feed the dam.
ii. Ongoing alien clearing action of farm staff has introduced large volumes of leaf and woody matter into the river, due to felling trees and leaving them adjacent to the stream. This in turn alters the nutrient load in the river and subsequently the macroinvertebrate community.

Apart from the above two existing aspects, no infrastructure or anthropogenic impacts were evident. In addition, based on the results from the invertebrate assessment, only site S2 showed poor conditions, with the other two sites indicating good to excellent water and aquatic ecosystem quality.

7.2 Design Phase Impacts

No impacts to the existing system is anticipated for the design phase of this project.

7.3 Construction Phase Impacts

This phase assesses the impacts associated with the construction of the dam wall and subsequent inundation of the dam.

7.3.1 Issue 1: Water Quality

Impact 1.1: Sedimentation and elevated turbidities

Cause and comment

Exposed soils can lead to a number of impacts such as erosion, sediment production and loss of topsoil. This may result in an accumulation of sediment and organic debris in watercourses, increased nutrient loads and changes to stream flows, which may affect aquatic biota.

Vegetation clearing results in the soils on the land becoming more prone to erosion. This is because there are fewer stabilizing structures within the soils, such as root systems and plant cover, to contain the water and bind the soil. This results in a net increase of surface water runoff, which can lead to excessive erosion. A secondary impact linked to this is the loss of topsoil. Topsoil is critical to successful plant growth and must be conserved at all times. Once lost, topsoil is extremely difficult to restore.

Increased erosion could lead to increased sedimentation of the watercourses into which surface runoff flows. Sedimentation can have severe negative impacts on surrounding aquatic environments including increased turbidity (which decreases light penetration into water, thereby reducing photosynthetic activities in the water column), reduced oxygen concentration in the water column and benthic environment, smothering of benthic biota resulting in loss of food and smothering of spawning beds.

Mitigation measures

- Undertake construction activities during the dry summer months.
- Prevent or strongly limit disturbance to water resources during the planning phase.

- Suitable temporary berms must be constructed prior to clearing in order to contain any soils that may be eroded by heavy rainfall. These soils should be rehabilitated as soon as possible in order to prevent ingress into surrounding water courses.
- Surface drainage that does not allow ponding and does not result in an increase in flow rates should be established.
- Maximum vegetation cover should be maintained outside the immediate area to be cleared, particularly in riparian areas, to act as silt traps.
- Natural drainage lines must not be impeded or otherwise interfered with.
- Erosion should be monitored over the entire site and, where initial indications of erosion are detected, appropriate remedial measures must be taken as soon as possible. Temporary berms may be needed to direct stormwater containing eroded material away from the river.

Significance statement
The impact associated with the sedimentation of rivers may occur. Without mitigation the significance was considered **HIGH -** and with mitigation it was considered to be **LOW -**.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Issue 1: Water Quality					
Impact 1.1: Sedimentation and elevated turbidities in river					
Without Mitigation	Medium term	Regional	Severe	Probable	**HIGH -**
With Mitigation	Short term	Localised	Moderate	May occur	**LOW -**

Impact 1.2: Contamination from pollutants

Cause and comment

Hazardous materials and chemical pollutants (e.g. hydrocarbons from construction machinery and vehicles, uncured cement and waste material) associated construction activities, as well as washing detergents and soap, poorly-treated domestic effluents from the construction camp, construction workers using riparian zones for ablutions, could pollute both groundwater and surface water. These pollutants could be harmful to aquatic biota and impact on drinking water quality downstream.

Mitigation
- Strict management of hazardous chemicals must be implemented.
- Prevention of hydrocarbon spills from machinery and vehicles by the use of drip-trays and permanent bunded areas for overnight parking. This should include any temporary workshops envisaged for the project. In addition, workshops should be fitted with oil traps and sumps to ensure that no contaminated water/hydrocarbons are allowed to escape.
- Domestic effluent from the construction camps should be stored temporarily in a safe manner (unlikely to leak or be breached), and should be removed by approved contractors weekly.
- All contaminated water run-off from the site must be contained and treated prior to discharge.

Significance Statement

The construction may cause a medium term risk of chemical pollution resulting in severe, medium term impacts of **MODERATE** significance in the Study Area without mitigation. With appropriate mitigation this impact should be reduced to **LOW** significance.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Issue 1: Water Quality					
Impact 1.2: Contamination from pollutants					
Without Mitigation	Medium term	Localised	Moderate	Probable	**MODERATE-**
With Mitigation	Short term	Localised	Slight	May occur	**LOW-**

7.3.2 Issue 2: Alteration of Flow regimes

Impact 2.1: Habitat Modification

Cause and comment

During construction and operation, earthworks associated with construction will alter the natural topography. This will destroy drainage lines and/or alter natural flow patterns within the project area.

Mitigation measures

- Where appropriate, slash and debris should be stockpiled above the new high water mark to prevent materials from entering dam during maintenance activities. This material must NEVER be disposed of in stream/river courses or in riparian zones.
- Minimise the number and size of stream crossings for vehicle movement within the riparian zones outside of the dam basin area (i.e. outside of the high water mark after construction). Where crossings are necessary, international best practice in the use of bridges, hardened fords, pipes and culverts should be adopted. Recommended stream crossing measures should include:
    - Minimise vehicular movement over streams (perennial and intermittent). Where crossing is necessary, a right angle approach should be used in addition to use of bridges, fords, pipe culverts, and other techniques to minimize impacts to stream banks, flow, water quality.
    - Crossing structures such as bridges, culverts and fords should be designed to withstand peak flows of high intensity storms, and ensure that movement of aquatic species is not impaired.
    - Vehicle movement over unprotected streambeds should be prevented. If crossing is necessary, a hard rock stream bottom is preferable.
    - Road drainage should be diverted to vegetation and not into the stream.
    - Approaches to crossing should be stabilized with aggregate to avoid increased sediment entering the stream.
    - Where possible, employ the access road to the west of the site, where one formal crossing point further downstream exists and can be utilised. This will reduce the need for vehicles to cross the existing stream area.

Significance statement

Preventing direct, adverse impacts to water resources and maintaining riparian zones is critical to protect water quality and quantity, associated aquatic habitats. Without mitigation the significance was considered **HIGH** and with mitigation it was considered to be **LOW**.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Issue 2: Alteration of flow regimes					
Impact 2.1: Habitat Modification					
Without Mitigation	Long term	Localised	Severe	Probable	**HIGH-**
With Mitigation	Short term	Localised	Slight	May occur	**LOW-**

Impact 2.2: Flow Modification

Cause and comment

During construction it may be necessary to divert, restrict or halt flow down the landscape temporarily to allow for construction vehicles, machinery and materials to operate. This will destroy drainage lines and alter the natural flow patterns, locations and ecosystems within the project area.

Significance statement

Altering or restricting flow past the existing Dam 2 will severely reduce the diversity and abundance of aquatic invertebrate species contained within the stream. Without mitigation the significance was considered **MODERATE** and with mitigation it was considered to be **NEGLIGIBLE**.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Issue 1: Alteration of flow regimes					
Impact 1.1: Flow modification					
Without Mitigation	Medium term	Localised	Moderate	Probable	**MODERATE -**
With Mitigation	Short term	Localised	Slight	Probable	**NEGLIGIBLE**

Mitigation measures

- Plan construction within the dry months of the year to reduce the sediment load and stormwater flow across site and into the stream.
- Plan construction phases and activities to minimise the disruption to the stream location and hydrological regime, by:
    - Avoid diverting flow as far as possible (if unavoidable, please see the measure below);
    - Should the stream be flowing during the construction period, ensure continuous water supply from the stream is allowed to flow past the construction zone. Should this necessitate diverting the stream, as far as possible employ non-mechanised means such as piping the flow (wide diameter pre-cast concrete or PVC piping as a temporary measure), as opposed to mechanical pumping which will harm the aquatic biota.
- Plan access for vehicles and materials via the western access road, to reduce the amount of crossing required over the stream.

7.4 Operational Phase

This section assesses the significance of the individual potential impacts associated with the operational phase of the proposed dam expansion activities on the aquatic habitats in the Study Area. Mitigation measures are recommended, where feasible.

7.4.1 Issue 3: Water Quality

Impact 3.1: Sedimentation and elevated turbidities in streams/dams

Cause and comment

During operation, Dam 2 will trap sediment contained within the stream, concentrating it in areas where the flow speed reduces significantly. Sediment load and turbidity around the outlet and immediately downstream thereof will be elevated, altering the local aquatic environment.

Mitigation measures

In addition to the mitigation measures stipulated for the construction phase in Section 7.3.1, the following is also recommended:

- The spillway must be designed to ensure an even, slow release of water from the dam when it is at full supply level (FSL), to reduce any erosion of the spillway.
- Appropriate engineering designs must be implemented to reduce spillway erosion and minimise flood risks, including the use of concrete step designs and geotextiles to trap ejected sediment (or another suitable design).

Significance statement

The impact associated with sedimentation of rivers/streams on site may occur due to the inlet/outlet works and associated concentration of silt and sediment within dams. Due to the mobility of sediment, the impact may be of significance to the region. Without mitigation the significance was considered **LOW** and with mitigation it was considered to be **LOW**.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Issue 1: Water Quality					
Impact 1.1: Sedimentation and elevated turbidities in rivers/streams					
Without Mitigation	Long term	Localised	Slight	May occur	**LOW -**
With Mitigation	Medium term	Localised	Slight	May occur	**LOW -**

7.4.2 Issue 4: Alteration of flow regimes

Impact 4.1: Flow modification

Cause and comment

The damming of water from the river will require a run-of-river scheme going forward. In addition, the new capacity of the proposed dam will be much greater than at present. All of these aspects will reduce the flow period and quantity of flow downstream of the proposed development.

Significance statement

The impact associated with hydrological regime and flow modification will occur and the impact was determined to be regional. Without mitigation the significance was considered **HIGH** and with mitigation it was considered to be **MODERATE**.

Impact	Effect			Risk or Likelihood	Overall Significance
	Temporal Scale	Spatial Scale	Severity of Impact		
Issue 2: Habitat Modification					
Impact 2.1: Disruption of ecological function					
Without Mitigation	Long term	Regional	Severe	Probable	**HIGH-**
With Mitigation	Long term	Study Area	Severe	May occur	**MODERATE-**

Mitigation measures

- Ensure that the Ecological Flow Reserve (EFR) is maintained, no matter the water level of the dam.
- Ensure that the design accounts for the release of water to meet the EFR.

7.5 Alternative Options

Four dam site alternatives were identified for enlargement on Hugosdale Farm (Figure 7.1 and Table 7.1), namely:

1. Dam 5
2. Dam 2
3. Intermediate dam
4. East-valley dam

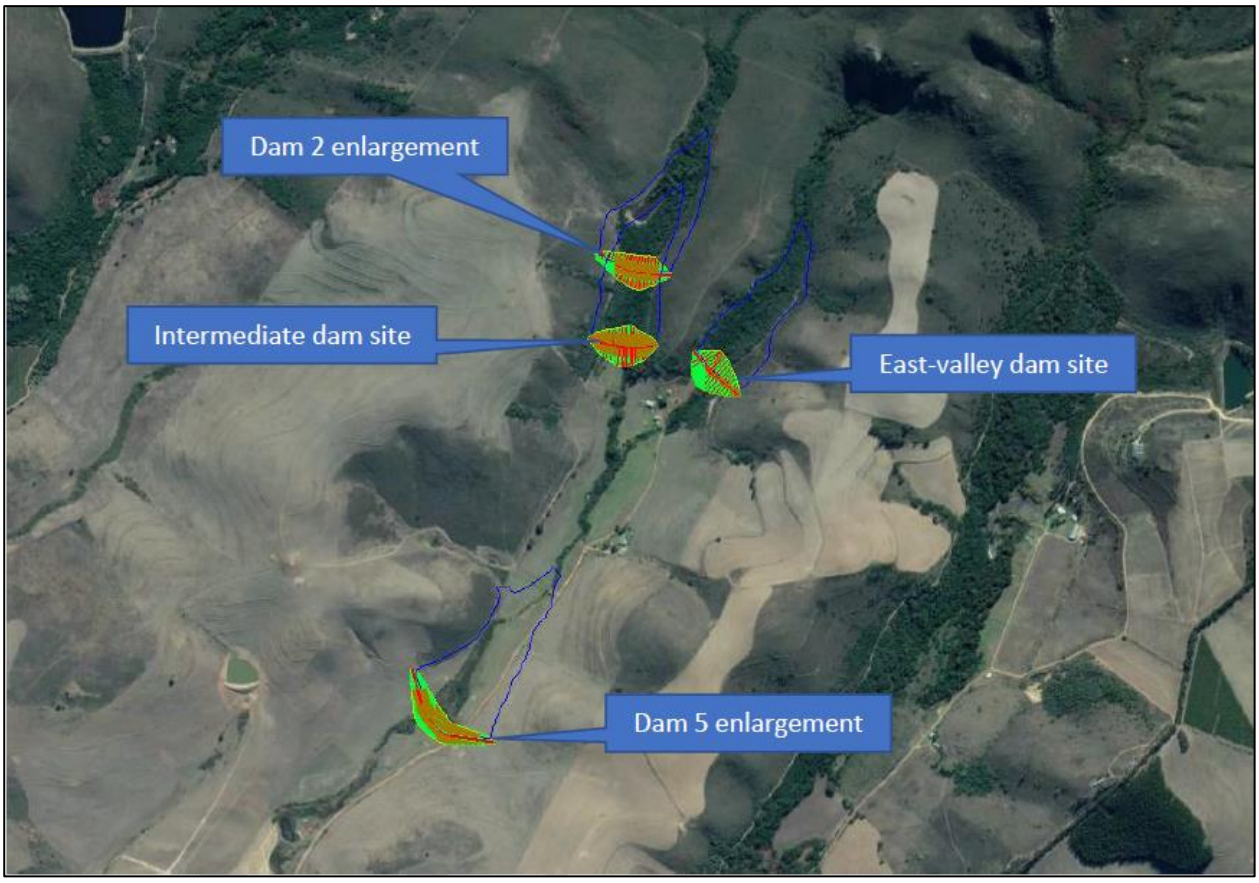


Figure 7.1. Dam alternatives showing their proximity and approximate surface area and location.

Table 7.1. Dam alternatives with capacity and cost comparison.

Alternative	Elevation (m/asl)	Existing Storage Capacity (m^3)	MAR (m^3)	Proposed Storage Capacity (m^3)	Proposed Dam wall (m)	Construction cost (Water/wall ratio*)
Dam 2	264	59 965	450 000	500 000	22	3.8
Intermediate	258		500 000	500 000	27	3.7
East-valley	260		180 000	500 000	27	3.9
Dam 5	216		315 000	500 000	15.5	4.4

* The water/wall ratio refers to the volume of storage capacity gained for every volume of earth/material moved. The higher ratio value increases the economy of the dam site.

- **Dam 2** enlargement (***proposed and preferred option***) is on a tertiary river at an elevation of 264m situated in Invasive Alien Woodland comprised of mostly black wattle. The MAR is 450 000 m³ which would fill a 500 000 m³ dam in a little over a year and is the second most expensive to build. Dam 2 would significantly save electricity by irrigating under gravity compared to that of Dam 5, due to its higher elevation.
- **Dam 5** is on a secondary river at an elevation of 216m. The majority of this site is agricultural land with degraded Shale Renosterveld. The enlargement will hold approximately 500 000 m³ and is the best suited to accumulate natural run-off which makes it the most economical option based on basin characteristics (water/wall ratio). However, due to the lower elevation the enlargement of Dam 5 would increase pumping and electrical costs.
- **East-valley dam** is situated on a tertiary river at 260m elevation situated in Invasive Alien Woodland and small portions of Shale Fynbos and Shale Renosterveld. This is not proposed for enlargement due to the low run-off volume from the smallest catchment area.
- **Intermediate dam** is situated on a tertiary river at 258m elevation vegetated with mostly invasive alien plant species and a small portion Shale Renosterveld. The proposed enlargement can hold approximately 500 000 m³ but is the least cost effective dam to build given it requires a 27m high wall and has the lowest 5.6 surface area.

In terms of the invertebrate composition and water quality on site, impacts for the intermediate dam will be greater than that of Dam 2, as no existing dam currently exists there, and thus much greater impact and disturbance of the stream will occur from creating a new dam at that location.

The impacts for the east valley dam site will also be similar, if not identical, to that of the intermediate dam, due to the similarly invaded nature of that stream, approximately the same disturbance and existing impacts for that stream, and roughly the same distance to source as represented by the Dam 2 stream. The east valley dam site will also represent an entirely new dam development, as opposed to simply upgrading capacity, and will thus also introduce novel impacts at that location.

Finally, the enlargement of Dam 5 will have less impacts, and generally impacts with a reduced severity when compared to that of Dam 2, by virtue of being located further downstream, with cleared vegetation (for grazing along the water course).This site will also have greater existing disturbance, due to the road crossing, the ongoing use of the river by staff and animals, the strong canalisation below the crossing, and the existing dam (albeit of a much smaller capacity). As such, this site is the preferred option in terms of the water quality and invertebrate composition. This site is however the least cost effective, with the lowest elevation and thus high pumping costs.

Should Dam 5 not be selected, Dam 2 is regarded as having the least impact of the remaining options, due to the presence of an already established dam, the highly invaded nature of the riverbank and partially covering an area already inundated by the existing dam.

8 CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusion and recommendations

The impacts rated in this report are indicated below (Table 8.1). Of the six impacts, three were rated as HIGH, two as MODERATE and one as LOW before mitigation, whereas this has been reduced to one MODERATE, four LOW and one NEGLIBILE respectively after mitigation.

Table 8.1. Impacts summary and mitigation measures for the impacts identified in the assessment chapter.

Impact	Significance pre-mitigation	Significance post-mitigation	Mitigation measures (Summarised – see Chapter 7 for complete descriptions)
CONSTRUCTION PHASE			
Impact 1.1: Sedimentation and elevated turbidities	**HIGH -**	**LOW -**	• Undertake construction activities during the dry summer months. • Prevent or limit disturbance to water resources. • Contain any soils that may be eroded by heavy rainfall, and rehabilitate as soon as possible after. • Establish adequate surface drainage systems. • Maintain maximum vegetation cover outside the clearing zone. • Natural drainage lines must not be impeded or otherwise interfered with. • Erosion should be monitored over the entire site and corrective actions taken where needed.
Impact 1.2: Contamination from pollutants	**MODERATE-**	**LOW-**	• Strict management of hazardous chemicals must be implemented. • Prevent of hydrocarbon spills from machinery and vehicles. • Safely store and dispose of domestic effluent from the construction camps. • All contaminated water run-off from the site must be contained and treated prior to discharge.
Impact 2.1: Habitat Modification	**HIGH-**	**LOW-**	• Slash and debris should be stockpiled above the new high water mark. • Minimise the number and size of stream crossings for vehicle movement.
Impact 2.2: Flow Modification	**MODERATE-**	**NEGLIGIBLE-**	• Plan construction within the dry months of the year. • Plan construction phases and activities to minimise the disruption to the stream location and hydrological regime. • Plan access for vehicles and materials via the western access road.
OPERATIONAL PHASE			

Impact 3.1: Sedimentation and elevated turbidities in streams/dams	**LOW -**	**LOW -**	In addition to the mitigation measures stipulated for the construction phase in Section 7.3.1, the following is also recommended: • The spillway must be designed to ensure an even, slow release of water from the dam when it is at full supply level (FSL), to reduce any erosion of the spillway. • Appropriate engineering designs must be implemented to reduce spillway erosion and minimise flood risks, including the use of concrete step designs and geotextiles to trap ejected sediment (or another suitable design).
Impact 4.1: Flow modification	**HIGH-**	**MODERATE-**	• Ensure that the Ecological Flow Reserve (EFR) is maintained, no matter the water level of the dam. • Ensure that the design accounts for the release of water to meet the EFR.

8.2 Monitoring

There are two main potential issues which need to be dealt with:

1. Habitat modification; and
2. Flow modification.

Habitat modification

Inundation of large areas will result from the dam expansion proposal (regardless of alternative selected), which will inevitably reduce available habitat within the upper reaches of the stream. These upper reaches are critical for the aquatic ecological health of the tributary, as the upper reaches provide the source of water, nutrients and sediment downstream. Upstream modifications are thus ecologically more damaging than downstream modifications. In particular, the proposal of expanding the dam to become a run-of-river type, as opposed to being fed from a side channel as is currently the case, will drastically alter the habitat quality and type within the impoundment footprint. As such, the designs should as far as possible take into account the need to preserve the existing channel and flow downstream.

Flow modification

The enlargement of the proposed dam will inevitably cause a reduction in downstream flow, nutrients and sediment, as greater amounts of each of those will be retained behind the dam walls. Furthermore, frequent releases via small sluices or outlets may be required to maintain the dam level. The alteration between releases and damming of water will inevitably alter the downstream flow and hydrological regime, further altering the ecosystem health and function. As such, the design should as far as possible take into account the need to preserve the existing flow patterns downstream of the dam to promote and preserve the current ecological function.

In order to address the abovementioned two concerns, the following monitoring programme (Table 8.2) should be implemented. Should monitoring results indicate a significant increase in turbidity levels and/or a change in Ecological Flow Reserve (when compared to the pre-construction monitoring findings), immediate corrective action should be taken to reduce the impacts on the stream and the aquatic environment.

Table 8.2. Monitoring program frequency and locations

Pre - Construction phase			
Monthly wet season turbidity monitoring for 2019.	S1	34° 3'50.23"S	19°40'33.02"E
	S2	34° 4'3.12"S	19°40'27.06"E
	S3	34° 4'16.99"S	19°40'21.93"E
	S4	34° 4'24.36"S	19°40'20.21"E
	S5	34° 4'35.91"S	19°40'14.39"E
Operation phase			
Monthly wet season turbidity monitoring for the first two years following inundation.	S1	34° 3'50.23"S	19°40'33.02"E
	S3	34° 4'16.99"S	19°40'21.93"E
	S5	34° 4'35.91"S	19°40'14.39"E
Monthly monitoring of dam release quantity.		At dam outlet	
Monthly rainfall monitoring.		At proposed dam site	

The above locations will allow for immediate, fine scale monitoring of impacts during the construction phase, as well as allowing for longer term monitoring of sediment and flow for two years after construction.

8.3 CONCLUSION

This report has addressed each of the items contained in the terms of reference, by establishing the baseline ecological state of the river adjacent Dam 2, determine the importance thereof and identifying upstream and downstream land use activities. Furthermore, this report has identified impacts of the proposed Dam 2 expansion, as it relates to the aquatic ecosystem health and invertebrate composition.

The Dam 5 expansion alternative is the preferred option, as it will limit aquatic ecosystem health impacts. The expansion of Dam 2 is regarded as the second best option should Dam 5 not be regarded as feasible. Overall, all of the HIGH rated impacts can be reduced to MODERATE or LOW, with mitigation. Habitat modification and flow modification are the two most important impacts. Particular care should be taken to mitigate these impacts during the design phase, and a suitable construction layout, design and methodology should be selected to reduce the severity of these impacts.

Should either option Dam 5 or Dam 2 be selected, the specialist is of the opinion that the impacts can be reduced to acceptable levels, provided that the mitigation measures are implemented rigorously. Thus, that the proposed development can proceed from an aquatic ecosystem perspective, should it be approved by the Competent Authority.

9 REFERENCES

Barbour, M.T., Gerritsen, J., Griffith, G.E., Frydenborg, R., McCarron, E., White, J.S. and Bastian, M.L. (1996) A framework for biological criteria for Florida streams using benthic macroinvertebrates. Journal of the North American Benthological Society, 15(2): 185-211.

Costanza R, d'Arge R, de Groot R, Farber S, Grasso M, Hannon B, Limburg K, Naeem S, O'Neill RV, Paruelo J, Raskin RG, Sutton P & M van den Belt, 1997.The value of the world's ecosystem services and natural capital. Nature volume 387, p. 253–260.

Department of Water Affairs and Forestry, 1996. South African Water Quality Guidelines (second edition). Volume 1: Domestic Use.

Department of Water Affairs and Forestry, 1996. South African Water Quality Guidelines (second edition). Volume 6: Agricultural Water Use: Aquaculture.

Dickens, C.W.S. and Graham, P.M. (2002) The South African Scoring System (SASS), Version 5, Rapid bioassessment method for rivers. *African Journal of Aquatic Science*, 27: 1-10.
http://www.epa.gov/waterscience/criteria/wqcriteria.htm.

Peru N & Doledec S, 2010. From compositional to functional biodiversity metrics in bioassessment: A case study using stream macroinvertebrate communities. Ecological Indicators 10(5): 1025 - 1036.

Resh, VH, Brown AV, Covich A & Wissmar RC, 1988. The role of disturbance in stream ecology. The Journal of North American Benthological Society 7(4): 433.

SA Explorer 2018. Greyon Climate [online]. Available from http://www.saexplorer.co.za/south-africa/climate/greyton_climate.asp [Accessed 04.09.2018].

Safe Drinking Water Foundation, Web: http://www.safewater.org/images/TDS_AND__pH.pdf Assessed: 30/03/2015

US EPA 2009: United States Environmental Protection Agency National Recommended Water Quality Criteria, Office of Water, Office of Science and Technology, 4304T, 2009.

10 APPENIDX A: APPENDIX D: SASS5 DATA SHEETS FOR SITES S1-S3

SASS Version 5 Score Sheet

Version date: Sept 2005

Date (dd:mm:yr):	31/07/2018				
RHP Site Code:		**Grid reference (dd mm ss.s) Lat:**	**S**	34° 3'50.23"S	(dd.ddddd)
Collector/Sampler:	Gideon Raath	**Long:**	**E**	19°40'33.02"E	
River:	Unnamed tributary of the Riviersonderend	**Datum (WGS84/Cape):**		WGS84	
Level 1 Ecoregion:		**Altitude (m):**		289masl	
Quaternary Catchment:	H60	**Zonation:**		Upper reach - near source	
	Temp (℃): 12.6 °C	**Routine or Project? (circle one)**	**Flow:**	Fast	
Site Description:	**pH:** 4.64	**Project Name:** Wijnberg Family Trust P345	**Clarity (cm):**		
Please see description in report	**DO (mg/L):** 10.80	Sample S1 - Upstream Location	**Turbidity:**	Low	
	Cond (mS/m): -		**Colour:**	Slightly tea-coloured	
	Riparian Disturbance:	Highly invaded by Acacia mearnsii along the river banks			
	Instream Disturbance:	Dam 2 located above this site - silt load			

Biotopes Sampled (tick & rate)	**Rating (1 - 5)**	**Time (min)**
Stones In Current (SIC)	4	2
Stones Out Of Current (SOOC)	2	1
Bedrock	3	1
Aquatic Veg	1	
MargVeg In Current	4	
MargVeg Out Of Current	4	
Gravel	5	
Sand	5	
Mud	5	
Hand picking/Visual observation	5	

Taxon	QV	S	Veg	GSM	TOT	Taxon	QV	S	Veg	GSM	TOT	Taxon	QV	S	Veg	GSM	TOT
PORIFERA (Sponge)	5					**HEMIPTERA (Bugs)**						**DIPTERA (Flies)**					
COELENTERATA (Cnidaria)	1					Belostomatidae* (Giant water bugs)	3					Athericidae (Snipe flies)	10			A	A
TURBELLARIA (Flatworms)	3					Corixidae* (Water boatmen)	3					Blepharoceridae (Mountain midges)	15				
ANNELIDA						Gerridae* (Pond skaters/Water striders)	5					Ceratopogonidae (Biting midges)	5		1		1
Oligochaeta (Earthworms)	1	A		A	A	Hydrometridae* (Water measurers)	6		1		1	Chironomidae (Midges)	2	A			A
Hirudinea (Leeches)	3					Naucoridae* (Creeping water bugs)	7					Culicidae* (Mosquitoes)	1				
CRUSTACEA						Nepidae* (Water scorpions)	3					Dixidae* (Dixid midge)	10				
Amphipoda (Scuds)	13	B	A	B	B	Notonectidae* (Backswimmers)	3					Empididae (Dance flies)	6				
Potamonautidae* (Crabs)	3					Pleidae* (Pygmy backswimmers)	4					Ephydridae (Shore flies)	3				
Atyidae (Freshwater Shrimps)	8					Veliidae/M...veliidae* (Ripple bugs)	5	1	1		A	Muscidae (House flies, Stable flies)	1				
Palaemonidae (Freshwater Prawns)	10					**MEGALOPTERA (Fishflies, Dobsonflies & Alderflies)**						Psychodidae (Moth flies)	1				
HYDRACARINA (Mites)	8			1	1	Corydalidae (Fishflies & Dobsonflies)	8					Simuliidae (Blackflies)	5	1		A	A
PLECOPTERA (Stoneflies)						Sialidae (Alderflies)	6					Syrphidae* (Rat tailed maggots)	1				
Notonemouridae	14					**TRICHOPTERA (Caddisflies)**						Tabanidae (Horse flies)	5	A		1	A
Perlidae	12					Dipseudopsidae	10					Tipulidae (Crane flies)	5				
EPHEMEROPTERA (Mayflies)						Ecnomidae	8	1		A	A	**GASTROPODA (Snails)**					
Baetidae 1sp	4					Hydropsychidae 1 sp	4		1	A	A	Ancylidae (Limpets)	6				
Baetidae 2 sp	6	B	A	B	B	Hydropsychidae 2 sp	6	A			A	Bulininae*	3				
Baetidae > 2 sp	12					Hydropsychidae > 2 sp	12					Hydrobiidae*	3				
Caenidae (Squaregills/Cainfles)	6					Philopotamidae	10	1	1	A	A	Lymnaeidae* (Pond snails)	3				
Ephemeridae	15					Polycentropodidae	12					Physidae* (Pouch snails)	3				
Heptageniidae (Flatheaded mayflies)	13					Psychomyiidae/Xiphocentronidae	8					Planorbinae* (Orb snails)	3				
Leptophlebiidae (Prongills)	9					**Cased caddis:**						Thiaridae* (=Melanidae)	3				
Oligoneuridae (Brushlegged mayflies)	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
Polymitarcyidae (Pale Burrowers)	10					Calamoceratidae ST	11					**PELECYPODA (Bivalvles)**					
Prosopistomatidae (Water specs)	15					Glossosomatidae SWC	11	A			A	Corbiculidae (Clams)	5				
Teloganodidae SWC (Spiny Crawlers)	12					Hydroptilidae	6					Sphaeriidae (Pill clams)	3				
Tricorythidae (Stout Crawlers)	9					Hydrosalpingidae SWC	15					Unionidae (Perly mussels)	6				
ODONATA (Dragonflies & Damselflies)						Lepidostomatidae	10					**SASS Score**		118	70	110	157
Calopterygidae ST,T (Demoiselles)	10					Leptoceridae	6			A	A	**No. of Taxa**		15	9	15	22
Chlorocyphidae (Jewels)	10					Petrothrincidae SWC	11					**ASPT**		7.8	7.7	7.3	7.1
Synlestidae (Chlorolestidae)(Sylphs)	8					Pisuliidae	10					**Other biota:**					
Coenagrionidae (Sprites and blues)	4					Sericostomatidae SWC	13	A	B	A	B						
Lestidae (Emerald Damselflies/Spreadwing	8					**COLEOPTERA (Beetles)**											
Platycnemidae (Stream Damselflies)	10					Dytiscidae/Noteridae* (Diving beetles)	5	A		1	A						
Protoneuridae (Threadwings)	8					Elmidae/Dryopidae* (Riffle beetles)	8	1			1						
Aeshnidae (Hawkers & Emperors)	8					Gyrinidae* (Whirligig beetles)	5					**Comments/Observations:**					
Corduliidae (Cruisers)	8					Haliplidae* (Crawling water beetles)	5										
Gomphidae (Clubtails)	6					Helodidae (Marsh beetles)	12			A	A						
Libellulidae (Darters/Skimmers)	4					Hydraenidae* (Minute moss beetles)	8	1	1	A	A						
LEPIDOPTERA (Aquatic Caterpillars/Moths)						Hydrophilidae* (Water scavenger beetles)	5										
Crambidae (Pyralidae)	12					Limnichidae (Marsh-Loving Beetles)	10										
						Psephenidae (Water Pennies)	10										

Procedure:

Kick SIC & bedrock for 2 mins, max. 5 mins. Kick SOOC & bedrock for 1 min. Sweep marginal vegetation (IC & OOC) for 2m total and aquatic veg 1m^2. Stir & sweep gravel, sand, mud for 1 min total. * = airbreathers
Hand picking & visual observation for 1 min - record in biotope where found (by circling estimated abundance on score sheet). Score for 15 mins/biotope but stop if no new taxa seen after 5 mins.
Estimate abundances: 1 = 1, A = 2-10, B = 10-100, C = 100-1000, D = >1000 S = Stone, rock & solid objects; Veg = All vegetation; GSM = Gravel, sand, mud SWC = South Western Cape, T = Tropical, ST = Sub-tropical
Rate each biotope sampled: 1=very poor (i.e. limited diversity), 5=highly suitable (i.e. wide diversity) Rate turbidity: V low, Low, Medium, High, Very High

SASS Version 5 Score Sheet

Version date: Sept 2005

Date (dd:mm:yr):	31/07/2018					
RHP Site Code:		**Grid reference (dd mm ss.s) Lat:**	**S**	34° 4'3.12"S		(dd.ddddd)
Collector/Sampler:	Gideon Raath	**Long:**	**E**	19°40'27.06"E		
River:	Unnamed tributary of the Riviersonderend	**Datum (WGS84/Cape):**		WGS84		
Level 1 Ecoregion:		**Altitude (m):**		276masl		
Quaternary Catchment:	H60	**Zonation:**		Upper reach		
	Temp (℃): 13.9 °C	**Routine or Project? (circle one)**	**Flow:**	Moderate		
Site Description:	**pH:** 5.5	**Project Name:** Wijnberg Family Trust P345	**Clarity (cm):**			
	DO (mg/L): 45.5	Sample S2 - Midstream location	**Turbidity:**	High		
Please see description in report	**Cond (mS/m):** -		**Colour:**	Dark tea-coloured		
	Riparian Disturbance:	Dam diversion located roughly 50m upstream				
	Instream Disturbance:					

Biotopes Sampled (tick & rate)	**Rating (1 - 5)**	**Time (min)**
Stones In Current (SIC)	4	2
Stones Out Of Current (SOOC)	3	1
Bedrock	3	1
Aquatic Veg	1	
MargVeg In Current	4	
MargVeg Out Of Current	3	
Gravel	5	
Sand	5	
Mud	5	
Hand picking/Visual observation	5	

Taxon	QV	S	Veg	GSM	TOT	Taxon	QV	S	Veg	GSM	TOT	Taxon	QV	S	Veg	GSM	TOT
PORIFERA (Sponge)	5					**HEMIPTERA (Bugs)**						**DIPTERA (Flies)**					
COELENTERATA (Cnidaria)	1					Belostomatidae* (Giant water bugs)	3					Athericidae (Snipe flies)	10				
TURBELLARIA (Flatworms)	3					Corixidae* (Water boatmen)	3		1		1	Blepharoceridae (Mountain midges)	15				
ANNELIDA						Gerridae* (Pond skaters/Water striders)	5					Ceratopogonidae (Biting midges)	5		A		A
Oligochaeta (Earthworms)	1					Hydrometridae* (Water measurers)	6					Chironomidae (Midges)	2	1		A	B
Hirudinea (Leeches)	3					Naucoridae* (Creeping water bugs)	7					Culicidae* (Mosquitoes)	1				
CRUSTACEA						Nepidae* (Water scorpions)	3		1		1	Dixidae* (Dixid midge)	10				
Amphipoda (Scuds)	13		1		1	Notonectidae* (Backswimmers)	3		1		1	Empididae (Dance flies)	6				
Potamonautidae* (Crabs)	3					Pleidae* (Pygmy backswimmers)	4					Ephydridae (Shore flies)	3				
Atyidae (Freshwater Shrimps)	8					Veliidae/M...veliidae* (Ripple bugs)	5					Muscidae (House flies, Stable flies)	1				
Palaemonidae (Freshwater Prawns)	10					**MEGALOPTERA (Fishflies, Dobsonflies & Alderflies)**						Psychodidae (Moth flies)	1				
HYDRACARINA (Mites)	8					Corydalidae (Fishflies & Dobsonflies)	8					Simuliidae (Blackflies)	5				
PLECOPTERA (Stoneflies)						Sialidae (Alderflies)	6					Syrphidae* (Rat tailed maggots)	1				
Notonemouridae	14					**TRICHOPTERA (Caddisflies)**						Tabanidae (Horse flies)	5				
Perlidae	12					Dipseudopsidae	10					Tipulidae (Crane flies)	5				
EPHEMEROPTERA (Mayflies)						Ecnomidae	8					**GASTROPODA (Snails)**					
Baetidae 1sp	4					Hydropsychidae 1 sp	4		1	1	A	Ancylidae (Limpets)	6				
Baetidae 2 sp	6	B	B	B	B	Hydropsychidae 2 sp	6					Bulininae*	3				
Baetidae > 2 sp	12					Hydropsychidae > 2 sp	12					Hydrobiidae*	3				
Caenidae (Squaregills/Cainfles)	6					Philopotamidae	10					Lymnaeidae* (Pond snails)	3	A			A
Ephemeridae	15					Polycentropodidae	12					Physidae* (Pouch snails)	3				
Heptageniidae (Flatheaded mayflies)	13					Psychomyiidae/Xiphocentronidae	8					Planorbinae* (Orb snails)	3				
Leptophlebiidae (Prongills)	9					**Cased caddis:**						Thiaridae* (=Melanidae)	3				
Oligoneuridae (Brushlegged mayflies)	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
Polymitarcyidae (Pale Burrowers)	10					Calamoceratidae ST	11					**PELECYPODA (Bivalvles)**					
Prosopistomatidae (Water specs)	15					Glossosomatidae SWC	11					Corbiculidae (Clams)	5				
Teloganodidae SWC (Spiny Crawlers)	12					Hydroptilidae	6					Sphaeriidae (Pill clams)	3				
Tricorythidae (Stout Crawlers)	9					Hydrosalpingidae SWC	15					Unionidae (Perly mussels)	6				
ODONATA (Dragonflies & Damselflies)						Lepidostomatidae	10					**SASS Score**		15	49	16	54
Calopterygidae ST,T (Demoiselles)	10					Leptoceridae	6					**No. of Taxa**		4	9	4	11
Chlorocyphidae (Jewels)	10					Petrothrincidae SWC	11					**ASPT**		3.75	5.4	4	4.9
Synlestidae (Chlorolestidae)(Sylphs)	8					Pisuliidae	10					**Other biota:**					
Coenagrionidae (Sprites and blues)	4					Sericostomatidae SWC	13										
Lestidae (Emerald Damselflies/Spreadwing	8					**COLEOPTERA (Beetles)**											
Platycnemidae (Stream Damselflies)	10					Dytiscidae/Noteridae* (Diving beetles)	5										
Protoneuridae (Threadwings)	8					Elmidae/Dryopidae* (Riffle beetles)	8										
Aeshnidae (Hawkers & Emperors)	8					Gyrinidae* (Whirligig beetles)	5					**Comments/Observations:**					
Corduliidae (Cruisers)	8					Haliplidae* (Crawling water beetles)	5										
Gomphidae (Clubtails)	6					Helodidae (Marsh beetles)	12					Very poor visibility due to the high turbidity and silt load.					
Libellulidae (Darters/Skimmers)	4	A	1	A	A	Hydraenidae* (Minute moss beetles)	8		B		B						
LEPIDOPTERA (Aquatic Caterpillars/Moths)						Hydrophilidae* (Water scavenger beetles)	5										
Crambidae (Pyralidae)	12					Limnichidae (Marsh-Loving Beetles)	10										
						Psephenidae (Water Pennies)	10										

Procedure:

Kick SIC & bedrock for 2 mins, max. 5 mins. Kick SOOC & bedrock for 1 min. Sweep marginal vegetation (IC & OOC) for 2m total and aquatic veg 1m^2. Stir & sweep gravel, sand, mud for 1 min total. * = airbreathers

Hand picking & visual observation for 1 min - record in biotope where found (by circling estimated abundance on score sheet). Score for 15 mins/biotope but stop if no new taxa seen after 5 mins.

Estimate abundances: 1 = 1, A = 2-10, B = 10-100, C = 100-1000, D = >1000 S = Stone, rock & solid objects; Veg = All vegetation; GSM = Gravel, sand, mud SWC = South Western Cape, T = Tropical, ST = Sub-tropical

Rate each biotope sampled: 1=very poor (i.e. limited diversity), 5=highly suitable (i.e. wide diversity) Rate turbidity: V low, Low, Medium, High, Very High

Dam 2 located above this site - silt load. Furthermore also plenty of Acacia mearnsii present

SASS Version 5 Score Sheet

Version date: Sept 2005

Date (dd:mm:yr):	31/07/2018				
RHP Site Code:		**Grid reference (dd mm ss.s) Lat:**	**S**	34° 4'16.99"S	(dd.ddddd)
Collector/Sampler:	Gideon Raath	**Long:**	**E**	19°40'21.93"E	
River:	Unnamed tributary of the Riviersonderend	**Datum (WGS84/Cape):**		WGS84	
Level 1 Ecoregion:		**Altitude (m):**		256masl	
Quaternary Catchment:	H60	**Zonation:**		Upper reach	
	Temp (℃): 12.1 °C	**Routine or Project? (circle one)**	**Flow:**	Moderate	
Site Description:	**pH:** 6.13	**Project Name:** Wijnberg Family Trust P345	**Clarity (cm):**		
Please see description in report	**DO (mg/L):** 88.6	Sample S3 - Downstream location	**Turbidity:**	Low	
	Cond (mS/m): -		**Colour:**	Slight tea-coloured	
	Riparian Disturbance:	Evidence of cattle crossing and drinking from the river roughly 10m downstream			
	Instream Disturbance:	Felled invasive species tree trunks and branches across entire length of sample site			

Biotopes Sampled (tick & rate)	**Rating (1 - 5)**	**Time (min)**
Stones In Current (SIC)	4	2
Stones Out Of Current (SOOC)	3	1
Bedrock	2	1
Aquatic Veg	2	
MargVeg In Current	3	
MargVeg Out Of Current	2	
Gravel	5	
Sand	5	
Mud	5	
Hand picking/Visual observation	5	

Taxon	QV	S	Veg	GSM	TOT	Taxon	QV	S	Veg	GSM	TOT	Taxon	QV	S	Veg	GSM	TOT
PORIFERA (Sponge)	5	A			A	**HEMIPTERA (Bugs)**						**DIPTERA (Flies)**					
COELENTERATA (Cnidaria)	1					Belostomatidae* (Giant water bugs)	3					Athericidae (Snipe flies)	10	B			B
TURBELLARIA (Flatworms)	3					Corixidae* (Water boatmen)	3			B	B	Blepharoceridae (Mountain midges)	15				
ANNELIDA						Gerridae* (Pond skaters/Water striders)	5					Ceratopogonidae (Biting midges)	5	A		A	B
Oligochaeta (Earthworms)	1	B		B	B	Hydrometridae* (Water measurers)	6					Chironomidae (Midges)	2	B	A	B	B
Hirudinea (Leeches)	3					Naucoridae* (Creeping water bugs)	7					Culicidae* (Mosquitoes)	1				
CRUSTACEA						Nepidae* (Water scorpions)	3					Dixidae* (Dixid midge)	10				
Amphipoda (Scuds)	13	A		1	A	Notonectidae* (Backswimmers)	3					Empididae (Dance flies)	6				
Potamonautidae* (Crabs)	3					Pleidae* (Pygmy backswimmers)	4					Ephydridae (Shore flies)	3				
Atyidae (Freshwater Shrimps)	8					Veliidae/M...veliidae* (Ripple bugs)	5					Muscidae (House flies, Stable flies)	1				
Palaemonidae (Freshwater Prawns)	10					**MEGALOPTERA (Fishflies, Dobsonflies & Alderflies)**						Psychodidae (Moth flies)	1				
HYDRACARINA (Mites)	8					Corydalidae (Fishflies & Dobsonflies)	8					Simuliidae (Blackflies)	5				
PLECOPTERA (Stoneflies)						Sialidae (Alderflies)	6					Syrphidae* (Rat tailed maggots)	1				
Notonemouridae	14					**TRICHOPTERA (Caddisflies)**						Tabanidae (Horse flies)	5				
Perlidae	12					Dipseudopsidae	10					Tipulidae (Crane flies)	5				
EPHEMEROPTERA (Mayflies)						Ecnomidae	8	A			A	**GASTROPODA (Snails)**					
Baetidae 1sp	4		A		A	Hydropsychidae 1 sp	4	A			A	Ancylidae (Limpets)	6				
Baetidae 2 sp	6	B		A	B	Hydropsychidae 2 sp	6					Bulininae*	3				
Baetidae > 2 sp	12					Hydropsychidae > 2 sp	12					Hydrobiidae*	3				
Caenidae (Squaregills/Cainfles)	6					Philopotamidae	10			1	1	Lymnaeidae* (Pond snails)	3	A			A
Ephemeridae	15					Polycentropodidae	12					Physidae* (Pouch snails)	3				
Heptageniidae (Flatheaded mayflies)	13					Psychomyiidae/Xiphocentronidae	8					Planorbinae* (Orb snails)	3				
Leptophlebiidae (Prongills)	9			1	1	**Cased caddis:**						Thiaridae* (=Melanidae)	3				
Oligoneuridae (Brushlegged mayflies)	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
Polymitarcyidae (Pale Burrowers)	10					Calamoceratidae ST	11					**PELECYPODA (Bivalvles)**					
Prosopistomatidae (Water specs)	15					Glossosomatidae SWC	11					Corbiculidae (Clams)	5				
Teloganodidae SWC (Spiny Crawlers)	12					Hydroptilidae	6					Sphaeriidae (Pill clams)	3				
Tricorythidae (Stout Crawlers)	9	A			A	Hydrosalpingidae SWC	15					Unionidae (Perly mussels)	6				
ODONATA (Dragonflies & Damselflies)						Lepidostomatidae	10					**SASS Score**		85	6	59	115
Calopterygidae ST,T (Demoiselles)	10					Leptoceridae	6	B		B	B	**No. of Taxa**		14	2	10	19
Chlorocyphidae (Jewels)	10					Petrothrincidae SWC	11					**ASPT**		6.0	3	5.9	6.0
Synlestidae (Chlorolestidae)(Sylphs)	8					Pisuliidae	10					**Other biota:**					
Coenagrionidae (Sprites and blues)	4					Sericostomatidae SWC	13										
Lestidae (Emerald Damselflies/Spreadwing	8					**COLEOPTERA (Beetles)**											
Platycnemidae (Stream Damselflies)	10					Dytiscidae/Noteridae* (Diving beetles)	5										
Protoneuridae (Threadwings)	8					Elmidae/Dryopidae* (Riffle beetles)	8	1			1						
Aeshnidae (Hawkers & Emperors)	8					Gyrinidae* (Whirligig beetles)	5					**Comments/Observations:**					
Corduliidae (Cruisers)	8					Haliplidae* (Crawling water beetles)	5										
Gomphidae (Clubtails)	6					Helodidae (Marsh beetles)	12										
Libellulidae (Darters/Skimmers)	4			A	A	Hydraenidae* (Minute moss beetles)	8										
LEPIDOPTERA (Aquatic Caterpillars/Moths)						Hydrophilidae* (Water scavenger beetles)	5	1			1	Steep banks on either side of the river.					
Crambidae (Pyralidae)	12					Limnichidae (Marsh-Loving Beetles)	10										
						Psephenidae (Water Pennies)	10										

Procedure:

Kick SIC & bedrock for 2 mins, max. 5 mins. Kick SOOC & bedrock for 1 min. Sweep marginal vegetation (IC & OOC) for 2m total and aquatic veg 1m^2. Stir & sweep gravel, sand, mud for 1 min total. * = airbreathers
Hand picking & visual observation for 1 min - record in biotope where found (by circling estimated abundance on score sheet). Score for 15 mins/biotope but stop if no new taxa seen after 5 mins.
Estimate abundances: 1 = 1, A = 2-10, B = 10-100, C = 100-1000, D = >1000 S = Stone, rock & solid objects; Veg = All vegetation; GSM = Gravel, sand, mud SWC = South Western Cape, T = Tropical, ST = Sub-tropical
Rate each biotope sampled: 1=very poor (i.e. limited diversity), 5=highly suitable (i.e. wide diversity) Rate turbidity: V low, Low, Medium, High, Very High

11 APPENDIX B: IMPACT ASSESSMENT METHODOLOGY

Five factors need to be considered when assessing the significance of impacts, namely:

1. Relationship of the impact to **temporal** scales - the temporal scale defines the significance of the impact at various time scales, as an indication of the duration of the impact.

2. Relationship of the impact to **spatial** scales - the spatial scale defines the physical extent of the impact.

3. The severity of the impact - the **severity/beneficial** scale is used in order to scientifically evaluate how severe negative impacts would be, or how beneficial positive impacts would be on a particular affected system (for ecological impacts) or a particular affected party.

   The severity of impacts can be evaluated with and without mitigation in order to demonstrate how serious the impact is when nothing is done about it. The word 'mitigation' means not just 'compensation', but includes concepts of containment and remedy. For beneficial impacts, optimization means anything that can enhance the benefits. However, mitigation or optimization must be practical, technically feasible and economically viable.

4. The **likelihood** of the impact occurring - the likelihood of impacts taking place as a result of project actions differs between potential impacts. There is no doubt that some impacts would occur (e.g. loss of vegetation), but other impacts are not as likely to occur (e.g. vehicle accident), and may or may not result from the proposed development. Although some impacts may have a severe effect, the likelihood of them occurring may affect their overall significance.

5. Each criterion is ranked to determine the overall **significance** of an activity (Table B.1). The criterion is then considered in two categories, viz. effect of the activity and the likelihood of the impact. The total scores recorded for the effect and likelihood are then read off the matrix presented in Table B.2a, to determine the overall significance of the impact. The overall significance is either negative or positive.

Table B.1: Ranking of Evaluation Criteria

EFFECT	**Temporal Scale**		
	Short term	Less than 5 years	
	Medium term	Between 5-20 years	
	Long term	Between 20 and 40 years (a generation) and from a human perspective also permanent	
	Permanent	Over 40 years and resulting in a permanent and lasting change that will always be there	
	Spatial Scale		
	Localised	At localised scale and a few hectares in extent	
	Study Area	The proposed site and its immediate environs	
	Regional	District and Provincial level	
	National	Country	
	International	Internationally	
	Severity	**Severity**	**Benefit**
	Slight	Slight impacts on the affected system(s) or party(ies)	Slightly beneficial to the affected system(s) and party(ies)
	Moderate	Moderate impacts on the affected system(s) or party(ies)	Moderately beneficial to the affected system(s) and party(ies)
	Severe/ Beneficial	Severe impacts on the affected system(s) or party(ies)	A substantial benefit to the affected system(s) and party(ies)
	Very Severe/ Beneficial	Very severe change to the affected system(s) or party(ies)	A very substantial benefit to the affected system(s) and party(ies)
LIKELIHOOD	**Likelihood**		
	Unlikely	The likelihood of these impacts occurring is slight	
	May Occur	The likelihood of these impacts occurring is possible	
	Probable	The likelihood of these impacts occurring is probable	
	Definite	The likelihood is that this impact will definitely occur	

** In certain cases it may not be possible to determine the severity of an impact thus it may be determined: Don't know/Can't know*

Table B.2 a: Matrix used to determine the overall significance of the impact based on the likelihood and effect of the impact.

Likelihood		Effect													
		3	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**
	1	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	2	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	3	6	7	8	9	10	11	12	13	14	15	16	17	18	19
	4	7	8	9	10	11	12	13	14	15	16	17	18	19	20

Table B.2 b: Description of Environmental Significance Ratings and associated range of scores

Significance Rate	Description	Score
Low	An acceptable impact for which mitigation is desirable but not essential. The impact by itself is insufficient even in combination with other low impacts to prevent the development being approved. These impacts will result in either positive or negative medium to short term effects on the social and/or natural environment.	LOW
Moderate	An important impact which requires mitigation. The impact is insufficient by itself to prevent the implementation of the project but which in conjunction with other impacts may prevent its implementation. These impacts will usually result in either a positive or negative medium to long-term effect on the social and/or natural environment.	MEDIUM
High	A serious impact, if not mitigated, may prevent the implementation of the project (if it is a negative impact). These impacts would be considered by society as constituting a major and usually a long-term change to the (natural &/or social) environment and result in severe effects or beneficial effects.	HIGH
Very High	A very serious impact which, if negative, may be sufficient by itself to prevent implementation of the project. The impact may result in permanent change. Very often these impacts are not able to be mitigated and usually result in very severe effects, or very beneficial effects.	VERY HIGH

The ***environmental significance*** scale is an attempt to evaluate the importance of a particular impact. This evaluation needs to be undertaken in the relevant context, as an impact can either be ecological or social, or both. The evaluation of the significance of an impact relies heavily on the values of the person making the judgment. For this reason, impacts of especially a social nature need to reflect the values of the affected society.

Prioritising

The evaluation of the impacts, as described above is used to assess the significance of identified impacts and determine which impacts require mitigation measures.

Negative impacts that are ranked as being of "**VERY HIGH**" and "**HIGH**" significance will be investigated further to determine how the impact can be minimised or what alternative activities or mitigation measures can be implemented. These impacts may also assist decision makers i.e. numerous **HIGH** negative impacts may bring about a negative decision. For impacts identified as having a negative impact of "**MODERATE**" significance, it is standard practice to investigate alternate activities and/or mitigation measures. The most effective and practical mitigations measures will then be proposed. For impacts ranked as "**LOW**" significance, no investigations or alternatives will be considered. Possible management measures will be investigated to ensure that the impacts remain of low significance.

12 APPENDIX C: SASS 5 ACCREDITATION CERTIFICATE

NATIONAL AQUATIC ECOSYSTEM HEALTH MONITORING PROGRAMME

Water and Sanitation
Environment Affairs

Water Research Commission

CERTIFICATE OF ACCREDITATION

This is to certify that

Justin Green

has met the requirements of the River Health Programme as a SASS5 Practitioner

COMPETENCY IN THE FOLLOWING AREAS HAVE BEEN DEMONSTRATED:

UNDERSTANDING OF THE SCOPE AND APPLICATION OF THE SASS5 METHOD.

DEMONSTRATION OF THE CORRECT SAMPLING PROTOCOLS

DEMONSTRATION OF THE CORRECT SAMPLE PREPARATION PROTOCOLS

IDENTIFICATION OF AQUATIC MACROINVERTEBRATES

COMPETENCY IS VALID FOR 3 YEARS FROM CERTIFICATE DATE

NATIONAL SASS5 AUDITOR

7 June 2017
DATE

13 APPENDIX D: CURRICULUM VITAE

JUSTIN GREEN
Curriculum Vitae

Coastal & Environmental Services

CONTACT DETAILS

Name of Company	**EOH Coastal & Environmental Services**
Designation	**Environmental Consultant**
Profession	GIS Specialist Surface Water Quality Specialist
Years with firm	**6 Years**
E-mail	Justin.Green@eoh.co.za j.green@cesnet.co.za
Office number	(+27) 46 622 2364
Nationality	South African
Professional body	**SACNASP**: Pending
Key areas of expertise	➢ Geographic Information Systems (GIS) ➢ Surface Water & Aquatic Assessment ➢ Wetland Assessment

PROFILE

Justin has a BSc. degree in Zoology and Entomology as well as a Post Graduate Diploma in Enterprise Management from Rhodes University. Justin has been an Environmental Consultant will CES for 5 years and has been involved in extensive work in Renewable Energy Projects and mining based projects. Justin has played an integral part in Basic Assessments and Environmental Impact Assessments. His work experience has been completed in South Africa, Lesotho, Mozambique, Zambia, Cameroon, Tanzania, Madagascar and The DRC.

He is a part of the Geographical Information Systems (GIS) team for the past 6 years with his primary experience through ArcGIS 10.1 and Quantum GIS 2.8.3. He has been involved in producing mapping data for a multitude of international projects all up to IFC and World Bank standards.

Justin has also made a considerable difference using OruxMaps for the purpose of specialist fieldwork and mapping purposes. He has recently become involved in specialising in surface water quality analyses using the South African Scoring System (SASS5) methodology as well as Wetland delineation.

EMPLOYMENT EXPERIENCE

EMPLOYMENT EXPERIENCE	**EOH Coastal & Environmental Services,** Environmental Consultant *April 2012 - Present* • Consultant • GIS Specialist • Surface Water & Aquatic Specialist • Wetland Specialist
ACADEMIC QUALIFICATIONS	**B.Sc. Zoology and Entomology** **Rhodes University,** Grahamstown 2010 **Post-Graduate Diploma in Enterprise Management** **Rhodes University,** Grahamstown 2011
COURSES	*1.* Rhodes University and CES, Grahamstown "**EIA Short Course**". 2012. *2.* IMBEWU, Port Elizabeth. "**Contaminated Land Workshop**". 2013. *3.* GroundTruth, Grahamstown. "**SASS5 Aquatic Biomonitoring Training Course**". 2015. *4.* Rhodes University, Grahamstown. "**Tools for Wetland Assessment**". 2017.

PROJECT RELATED EXPERIENCE

BIRD & BAT MONITORING PROGRAMMES	**1) Project**: **Innowind Waainek Wind Farm (2017)** ○ **Location**: Grahamstown, South Africa ○ **Role**: Bird and Bat mortality counts Climate data collection Bat call identification
RESSETLEMENT ACTION PLANS (RAP)	**1) Project**: **Kenmare Pilivili Mine (2017)** ○ **Location**: Moma, Mozambique. ○ **Role**: Data Management & Map Production **2) Project**: **TOTAL EAST AFRICA MIDSTREAM B.V (2018) East African Crude Oil Pipeline (EACOP)** ○ **Location**: Moma, Mozambique. ○ **Role**: Data Management & Field team management
WETLANDS, SURFACE WATER & AQUATIC ASSESSMENTS	**1) Project: Triton Nicanda Hills Graphite Mine (2014)** ○ **Location**: Montepuez, Mozambique. ○ **Role**: Surface water quality testing and aquatic invertebrate collection using the South African Scoring System (SASS) **2) Project: Sasol Nhangonzo Mozambique Biodiversity Assessment (2015)** ○ **Location**: Inhassorro, Mozambique. ○ **Role**: Surface water quality testing and aquatic invertebrate collection using the South African Scoring System (SASS) **3) Project: Alphamin Resources Mining ESIA (2015)** ○ **Location**: Democratic Republic of Congo (DRC). ○ **Role**: Surface water quality testing and aquatic invertebrate collection using the South African Scoring System (SASS) **4) Project: GK Ancuabe Graphite Mine S.A. (2016)** ○ **Location**: Ancuabe, Mozambique. ○ **Role**: Surface water quality testing and aquatic invertebrate collection using the South African Scoring System (SASS) **5) Project: Murrimo Macadamias, Potatoes and Grains Project (2016)** ○ **Location**: Gúrùe, Zambezia Province, Mozambique.

- **Role**: Surface water quality testing and aquatic invertebrate collection using the South African Scoring System (SASS)

6) **Project**: **Kenmare Pilivili Mine (2017)**
   - **Location**: Moma, Mozambique.
   - **Role**: Surface water quality testing

7) **Project**: **Triton Ancuabe Graphite Mine (2017)**
   - **Location**: Ancuabe, Mozambique.
   - **Role**: Surface water quality testing and aquatic invertebrate collection using the South African Scoring System (SASS)

8) **Project**: **Triton Ancuabe Graphite Mine (2018)**
   - **Location**: Ancuabe, Mozambique.
   - **Role**: Surface water and Groundwater pre-construction monitoring

9) **Project**: **JCM Cameroon Solar PV (2017)**
   - **Location**: Mbalmayo, Cameroon.
   - **Role**: Wetland Delineation & Water quality

10) **Project**: **Suni Balama Graphite Mine (2018)**
   - **Location**: Balama, Mozambique.
   - **Role**: Surface water quality testing and aquatic invertebrate collection using the South African Scoring System (SASS)

BASIC ASSESSMENT AND ENVIRONMENTAL IMPACT ASSESSMENT PROJECTS

Environmental and Social Impact Assessment (ESIA)

- Environmental and Social Impact Assessment Ranobe Mine Project, Southwest Region, Madagascar (2013)
- RHDHV – Biofuel ESIA Disclosure, Sofala Province, Mozambique (2014)
- London Mining Marampa Iron Ore Sierra Leone (2014)
- Proposed Upgrade of the Maroua Oil Mill in the Republic of Cameroon (2014)
- Proposed Upgrade of the Garoua Oil Mill in the Republic of Cameroon (2014)
- Green Resources Medium Density Fibreboard Production, Niassa Province, Mozambique (2014)

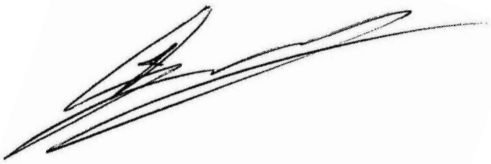
Environmental Impact Assessment (EIA) and pre-feasibility assessments	• Environmental Impact Statement: Sentinel Deposit, North Western Province, Zambia (2012) • Mooi-Mgeni Transfer Scheme – Phase 2, Kwazulu-Natal Province, South Africa (2013) • Syrah Balama Graphite Project: Pre-feasibility and Environmental Scoping Report, Mozambique (2013) • Kamiesberg Project, Namakwaland, South Africa (2013) • Belmont Valley Golf Course and Makana Residential Estate (EIA) (2013) • Eastern Cape Biofuels Production (SEA) (2016) • Resettlement Action Plan: Murrimo Macadamias, Potatoes and Grains Project (2015)
International Mining Projects	• Toliara Mineral Sands Rehabilitation and Offset Strategy Report, Madagascar (2014) • Syrah Resources, Cabo del Gado, Mozambique (2014) • Baobab Mining, Tete, Mozambique (2014) • Triton Minerals Nicanda Hill Graphite Mine, Cabo del Gado, Mozambique (2014) • Alphamin Resources ESIA, DRC (2016) • Kenmare Pilivili Heavy Minerals Mine ESIA, Moma, Mozambique (2017) • Metals of Africa Graphite Mine, Ancuabe, Mozambique (2017) • Triton Minerals Ancuabe Graphite Mine, Cabo del Gado, Mozambique (2017)
Wind Energy Projects (EIA)	• MakanaOne Wind Energy Project (2012) • Middleton Wind Energy (2012) • Mossel Bay Wind Energy Project (2012) • Plan 8 Wind Energy Project (2012) • Grassridge Wind Energy Project (Coega) (2013) • St Lucia Wind Energy Project (2013) • Cookhouse Wind Energy Project (2013) • Dassiesridge Wind Energy (2014) • Inyanda-Roodeplaat Farm Wind Energy (2015)
Solar Energy Projects (EIA)	• MakanaOne Brack Kloof Photovoltaic Solar Energy Project (2012) • MakanaOne Hilton Photovoltaic Solar Energy Project (2012) • MakanaOne Table Hill Photovoltaic Solar Energy Project (2012) • MakanaOne Watt Hill Photovoltaic Solar Energy Project (2012) • JCM Solar PV Project, Cameroon (2017)

Basic Assessment (BAR)	• Resort Development On Portion 17 of Farm Gorah 398 (2012) • Walmer 17th Avenue 132KV Powerline (2012) • SANRAL Grahamstown to Fish River Road Upgrade (2013) • Rehabilitation of R61 Section 2 Elinus Farm (Km42.2) To N10 (Km85), Cradock, Eastern Cape) (2013) • Rehabilitation of N10 Section 3 between Riet River Bridge (km 45.2) and Tarka Bridge (km 68.5), Cradock, Eastern Cape (2013) • Uhambiso Glenhurd Road Upgrade & Baakens River Bridge (2015) • Innowind Ukomeleza & Olifantskop Substations and Overhead Powerlines (2015) • Grahamstown Fairewood Estate Development (2015)
Additional Experience	**Faunal Assessments** • Lesotho Highlands Water Project ESIA, Lesotho (2014) ○ Mammal component for Faunal specialist study (trapping and identification), assistant to Faunal specialist. **Ecological Assessments** • Borrow Pit in Libode, Eastern Cape Province (2014) • LHDA Botanical Survey and Impact Assessment, Lesotho (2014) • Kenmare Terrestrial Monitoring Program, Specialist Survey, MOMA, Mozambique (2014 & 2016) • Doorndraai Citrus Ecological Assessment, Bedford, South Africa (2017) **Due Diligence** • Coega Brick Due Diligence (2012) **Environmental Auditing** • Strowan Mine Environmental Auditing (2013) • Grahamstown Municipal Dump Auditing (2017) • Lalibela Lentaba Lodge Construction auditing (2017) **Policy and Guidelines** • Water use licence applications for various river crossings for Rehabilitation of R61 Section 2 Elinus Farm (Km42.2) To N10 (Km85), Cradock, Eastern Cape (BAR) (2013) **Mining applications** • Mining Application for Hard Rock Quarry and borrow pits for N10-3 road upgrade (2013) • Mining Application for Hard Rock Quarry and borrow pits for R61-2 road upgrade (2013) • Mining Application for Hard Rock Quarries and borrow pits for N2 road upgrade (2013) • Zirco Kenhardt Prospecting Application (2015)

Languages	Speak	Read	Write
English	Excellent	Excellent	Excellent
Afrikaans	Satisfactory	Satisfactory	Satisfactory
Portuguese	Poor	Satisfactory	Poor

CERTIFICATION

I, the undersigned, certify that to the best of my knowledge and belief, this CV correctly describes me, my qualifications, and my experience. I understand that any wilful misstatement described herein may lead to my disqualification or dismissal, if engaged.



JUSTIN GREEN DATE: 23rd AUGUST 2018

Gideon Raath
Curriculum Vitae

Coastal & Environmental Services

CONTACT DETAILS

Name of Company	**EOH Coastal & Environmental Services**
Designation	**Mr Gideon Raath – Environmental Consultant**
Profession	Consulting Ecological Specialist; Wetland Specialist
Years with firm	3.5
E-mail	gideon.raath@eoh.com g.raath@cesnet.co.za
Office number	(011) 607 8389
Nationality	South African
Professional body	**SACNASP**: South African Council for Natural and Scientific Professionals (No. 117178).

Key areas of expertise

- Environmental Authorisations (including MPRDA applications)
- Water Use Licencing;
- Ecological and wetland specialist reports
- GIS and public participation

PROFILE

Gideon holds an MSc (Geography and Environmental Management; SU), a BSc Honours (Ecology and Environmental Studies - Cum laude; Wits) and a BSc (Geography and Environmental Management; UJ). His MSc thesis focused on the hydrological impact on the spatial distribution of invasive Eucalyptus trees along the Breede River, while his honours thesis evaluated ethnobotanical relationships around the Rio Tinto copper mine in Phalaborwa. Most recently he has worked as the Monitoring & Evaluation Project Manager for the City of Cape Town's invasive species unit. Gideon's GIS background includes the management of the City of Cape Town invasive species GIS database, involving the storage, management, recall and quality control off all sightings, clearance visits and known infestations.

Further experience include mapping for various consulting projects, boundary verification through ground-truthing and the spatial mapping and delineation component of this MSc research. Gideon has further attended public participation

workshops, and has been involved with IAP identification, translation, public meetings and engagement for a variety of projects, mainly within the Afrikaans speaking Northern Cape.

Gideon's general consulting expertise includes project management, EIA and EMPr documentation development, integrated water use license applications, specialist botanical and ecological impact assessments, specialist wetland delineation and impact assessments, GIS applications and mapping. Gideon works from the Johannesburg office, and is interested in invasion ecology, treatment of groundwater pollution through phytoremediation, botanical and wetland specialist studies, GIS application for ecology and environmental management, and the EIA processes in general.

EMPLOYMENT EXPERIENCE

Environmental Consultant, EOH Coastal and Environmental Services

February 2014 - current

- Responsible for project management and reporting for small to medium size projects including water use licenses, BA and EIA reports, MPRDA authorisation documentation and specialist reports.
- Proposals and business development forms a large part of my portfolio.
- Won R 1.5 million of work through various projects over a two year period.
- Successfully completed 9 different authorisation projects to Environmental Authorisation without incident or rejection over a period of two years
- Expanded specialist skills and reporting to wetland delineation, ecological reports and botanical assessments.
- Completed SASS5 biomonitoring course, aiming for accreditation in July 2019.

Project Manager (Professional Officer), City of Cape Town Invasive Species Unit (ISU)

Dates

- Entrusted with the monitoring & evaluation project portfolio, which entailed the establishment of an invasive species monitoring & evaluation system for the ISU, as well as GIS

database management, quality assurance and reporting thereof. This position required managing a small staff compliment (dealing directly with GIS database management), managing time and budgets for the monitoring division, conducting monitoring trials and research, writing species management plans as well as handling the GIS database, quality control, verification and integrity for the ISU.

- Initiated the implementation of a monitoring & evaluation protocol for the City of Cape Town.
- Initiated a research and monitoring programme for *Echium plantagineum* in the Tygerberg Nature Reserve and City limits, to ensure effective control techniques are applied in future.
- Initiated a review and optimisation of ISU GIS data for all the different management zones.
- Expanded plant identification skills.

Department Assistant, University of Stellenbosch
Dates

- Technical editing of academic reports.
- Formatting of PhD and MSc reports on a weekly basis, with short turnaround time and good quality feedback.

Teaching Assistant, University of the Witwatersrand
Dates

- Responsible for practical tutorials and marking of 1st year medical students. Included zoology and botany.

Co-founder and member, Codeon Networking CC
January 2006 – November 2010 (part time)

- Small business owner, responsible for all facets of the business.
- Self-taught HTML, CSS, PHP and MySQL.
- Won and produced two medium enterprise websites serving the gaming community. Websites required user profiles & permissions,

CMS system and automated payment options as functionality.

- Development and maintenance of a user database and account management system.

ACADEMIC QUALIFICATIONS

Stellenbosch University, Stellenbosch, Western Cape.

- M.Sc. Geography and Environmental Science
  January 2012 – December 2014

University of the Witwatersrand, Johannesburg, Gauteng

- B.Sc. Hons. Ecology, Environment and Conservation (Cum Laude)
  January 2011 – December 2011

University of the Witwatersrand, Johannesburg, Gauteng

- B.Sc. Life and Environmental Sciences

January 2006 – December 2010

COURSES

1. GroundTruth Aquatic Consulting, Pietermaritzburg.
   "GroundTruth SASS5 competency course"; 2017.

2. Department of Water and Sanitation, Pretoria.
   "DWS 21C&I GA training workshop"; 2016.

3. IAIA South Africa, Cape Town.
   "IAIAsa Public Participation Process Workshop"; 2016.

4. EOH Coastal and Environmental Services, Grahamstown.
   "EIA Theory and application"; 2015.

5. City of Cape Town, Cape Town.
   "Water Safety Training, Herbicide safety and application for weed control, Snake awareness training, City of Cape Town "; 2014.

6. University of Cape Town, Cape Town.

"Habitable Planet Workshop "; 2011.

CONSULTING EXPERIENCE

1. Thabazimbi Local Municipality & Anglo American, Thabazimbi, Limpopo Province. 2018/2019.
   "Integrated Waste Management Plan, 2018".

2. Frances Baard Local Municipality, Kimberley, Northern Cape Province. 2018/2019.
   "Scoping and EIR authorisation, Water Use Licence, for the Ganspan tourism facility development".

3. ER Galvanizers Pty Ltd, Johannesburg, Gauteng. 2018/2019.
   "Atmospheric Emissions Licence, Basic Assessment for the Galvanizing plant and operations".

4. SANRAL Zandkraal-Windburg N1 road upgrade, Windburg, Free State Province. 2018/2019.
   “SANRAL Zandkraal-Windburg N1 Quarry S&EIR authorisation, Water Use Licence.”

5. SANRAL Masekwaspoort N1 road upgrade, Musina, Limpopo Province. 2018/2019.
   “SANRAL Masekwaspoort N1 Road Upgrade BA, Quarry Mining Licence Application and Water Use Licence Application.”

6. South African National Biodiversity Institute (SANBI), Pretoria, Gauteng. 2018/2019.
   “Office complex development within the Pretoria National Botanical Gardens".

7. Vergenoeg Mining Company (Pty) Ltd, Emalahleni, Mpumalanga. 2018.
   "Mining Permit Renewal application".

8. SANRAL Polokwane N1 Ring Road Upgrade, Polokwane, Limpopo Province. 2018.
   “SANRAL Polokwane N1 Ring Road Upgrade Basic Assessment.”

9. TRANSNET, Rustenburg, North-West. 2018.
   “Boshoek Loop Rail Upgrade BAR and Water Use Licence".

10. TRANSNET, Rustenburg, North-West. 2018.
    “Heysterkrand Loop Rail Upgrade BAR".

11. TRANSNET, Roodepoort, Gauteng. 2018.
    “Environmental Compliance Auditing".

12. City of Johannesburg Nature Reserves, Johannesburg. 2017/2018.
    “City of Johannesburg nature reserve proclamation boundary verification (Phase II).”

13. Ramotshere Moiloa Local Municipality, Zeerust, North-West Province, 2018/2019.
    "Corner Berg and Drooge Street township development".

14. Ramotshere Moiloa Local Municipality, Zeerust, North-West Province, 2018/2019.
    "Corner Kort and Bree Street township development".

15. Door of Hope, Johannesburg, Gauteng, 2018/2019.
    "Hope Village township development".

16. Grafex Limitada (Triton Minerals Ltd), Ancuabe, Mozambique. 2018.
    "Baseline vegetation monitoring assessment and programme".

17. Grafex Limitada (Triton Minerals Ltd), Ancuabe, Mozambique. 2017.
    "Prospecting pit rehabilitation programme."

18. Grafex Limitada (Triton Minerals Ltd), Ancuabe, Mozambique. 2017.
    "Assisting with the ESIA reporting for MITADER."

19. SANRAL Bierspruit R510 road upgrade, Thabazimbi,

Limpopo Province. 2017.
"SANRAL Bierspruit R510 road upgrade Water Use Licence, Basic Assessment and Borrow Pit authorisation."

20. SANRAL Hendrina N11 road upgrade, Hendrina, Mpumalanga Province. 2017.
"Construction Monitoring and DMR environmental authorisation"

21. Sol Plaatje Local Municipality, Kimberley, Northern Cape, 2017.
"Diamond Park Township Development Section 24G".

22. Riverside Community Church, Johannesburg, Gauteng, 2017.
"Kibler Park Church Development Ecological Assessment".

23. Barberton IAPS, Barberton, Mpumalanga. 2016/2017.
"Barberton IAPS Waste Water Treatment Works development."

24. ACSA Jones Road, Johannesburg, Gauteng. 2016/2017.
"ACSA Jones Road Filling Station Basic Assessment."

25. SANRAL Caledon, Caledon, Western Cape. 2016/2017.
"SANRAL Caledon N2 Section 3 road upgrade project Basic Assessment, Water Use Licence and Specialist reports."

26. Boschendal, Stellenbosch, Western Cape. 2015/2016.
"Boschendal Wine Estate hydro-electric power station Water Use Licence and S24G application."

27. Quoin Point, Bredasdorp, Western Cape. 2016.
"DEA Quoin Point dune vegetation study contributions."

28. City of Johannesburg Nature Reserves, Johannesburg.

2015/2016.
"City of Johannesburg nature reserve proclamation boundary verification (Phase I)."

29. G7 Renewables, Matjiesfontein, Western Cape. 2015/2016.
"G7 Renewable Energy (Pty) Ltd Brandvalley and Rietkloof EIA contributions."

30. Zirco Resources, Kamiesberg, Northern Cape. 2015.
"Zirco Resources Kamiesberg heavy mineral sand mine Water Use Licence."

31. Biotherm, Cookhouse, Eastern Cape. 2015.
"Biotherm Energy Golden Valley Wind Energy Facility ESAP."

32. iGas, Saldanha, Western Cape. 2015.
"Central Energy Fund iGas integrated biodiversity report contributions."

33. Triton Minerals, Ancuabe, Cabo Delgado Province, Mozambique. 2015.
"Triton Minerals Limited Ancuabe and Nicanda Hills EPDA contributions."

34. Kenhardt, Kenhardt, Northern Cape. 2015.
"Kenhardt Northern Cape tin prospecting Public Participation."

35. Almenar, Kenhardt, Northern Cape. 2015.
"Almenar Northern Cape tin prospecting Public Participation."

36. Mayfield Quarry, Grahamstown, Eastern Cape. 2015.
"Mayfield Quarry Rehabilitation plan."

37. PRDW Breakwater, Cape Town, Western Cape. 2014.
"PRDW Cape Town harbour breakwater rehabilitation EMPr."

38. PRDW Bushman's, Kenton-on-Sea , Eastern Cape.

2014.
"PRDW Bushman's Estuary dune encroachment project management."

39. Mosselbay IPP, Mosselbay, Western Cape. 2014.
"Mosselbay Energy IPP (Pty) Ltd EA Amendment."

40. G7 Renewable Energy, Matjiesfontein, Western Cape. 2015/2016.
"132kV BAR & EMPr."

41. Kraaifontein WUL, Cape Town, Western Cape. 2014.
"Western Cape Government (PGWC) Bloekombos (Kraaifontein) botanical baseline and impact assessment report."

MEMBERSHIPS

- Golden Key International Honour Society – University of the Witwatersrand Chapter.
- South African Council for Scientific Natural Professionals (SACNASP): Certified Natural Scientist) – Application pending (May 2017).
- IAIAsa (Membership No. 3619).

CERTIFICATION

I, the undersigned, certify that to the best of my knowledge and belief, this CV correctly describes me, my qualifications, and my experience. I understand that any wilful misstatement described herein may lead to my disqualification or dismissal, if engaged.

Gideon Raath Date: 18 June 2018

environmental affairs

Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

DETAILS OF THE SPECIALIST, DECLARATION OF INTEREST AND UNDERTAKING UNDER OATH

	(For official use only)
File Reference Number:	
NEAS Reference Number:	DEA/EIA/
Date Received:	

Application for authorisation in terms of the National Environmental Management Act, Act No. 107 of 1998, as amended and the Environmental Impact Assessment (EIA) Regulations, 2014, as amended (the Regulations)

PROJECT TITLE

PROPOSED ENLARGEMENT OF DAM 2 ON HUGOSDALE FARM (RE/141), NEAR GREYTON IN THE WESTERN CAPE

Kindly note the following:

1. This form must always be used for applications that must be subjected to Basic Assessment or Scoping & Environmental Impact Reporting where this Department is the Competent Authority.
2. This form is current as of 01 September 2018. It is the responsibility of the Applicant / Environmental Assessment Practitioner (EAP) to ascertain whether subsequent versions of the form have been published or produced by the Competent Authority. The latest available Departmental templates are available at https://www.environment.gov.za/documents/forms.
3. A copy of this form containing original signatures must be appended to all Draft and Final Reports submitted to the department for consideration.
4. All documentation delivered to the physical address contained in this form must be delivered during the official Departmental Officer Hours which is visible on the Departmental gate.
5. All EIA related documents (includes application forms, reports or any EIA related submissions) that are faxed; emailed; delivered to Security or placed in the Departmental Tender Box will not be accepted, only hardcopy submissions are accepted.

Departmental Details

Postal address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Private Bag X447
Pretoria
0001

Physical address:
Department of Environmental Affairs
Attention: Chief Director: Integrated Environmental Authorisations
Environment House
473 Steve Biko Road
Arcadia

Queries must be directed to the Directorate: Coordination, Strategic Planning and Support at:
Email: EIAAdmin@environment.gov.za

1. SPECIALIST INFORMATION

Specialist Company Name:	Coastal and Environmental Services			
B-BBEE	Contribution level (indicate 1 to 8 or non-compliant)	1	Percentage Procurement recognition	Unknown
Specialist name:	GIDEON RAATH			
Specialist Qualifications:	M. Sc. Geography and Environmental Studies (SUN), B. Sc. (Hons) Ecology, conservation and the environment (WIT), B. Sc. Geography and Environmental Management (UJ)			
Professional affiliation/registration:	SACNASP: 117178 (Pr.Sci.Nat.)			
Physical address:	First floor, Block 2, 5 Woodlands Drive Office Park, Woodlands Drive, Woodmead, 2191			
Postal address:	Same as physical			
Postal code:	2191	Cell:	Not supplied	
Telephone:	011 656 3237	Fax:	086 684 0547	
E-mail:	gideon@savannahsa.com			

2. DECLARATION BY THE SPECIALIST

I, Gideon Raath, 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 Act, Regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, Regulations and all other applicable legislation;
- I have no, 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; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the Specialist

COASTAL AND ENVIRONMENTAL SERVICES

Name of Company:

18 April 2019

Date

3. UNDERTAKING UNDER OATH/ AFFIRMATION

I, Gideon Raath, swear under oath / affirm that all the information submitted or to be submitted for the purposes of this application is true and correct.

Signature of the Specialist

COASTAL AND ENVIRONMENTAL SERVICES

Name of Company

18 April 2019

Date

Signature of the Commissioner of Oaths

23/4/19

Date

COMMISSIONER OF OATHS EX OFFICIO
ROBERTO SMALL
PRACTISING ATTORNEY OF SA
MOTSEKUOA INCORPORATED ATTORNEYS
OFFICE 3, DUNWOODY CENTRE
CNR WESTERN SERVICE ROAD & WOODLANDS DR
WOODMEAD, SANDTON
(T) 011 568 5040 (F) 086 244 3072