Assessment of an Existing Dam and Road and a Proposed New Dam on the Ruiterbos River in the Outeniqua Game Farm, Mossel Bay, Western Cape.

Specialist Aquatic Biodiversity Assessment

Prepared For:	Eco Route
Author:	Dr. J.M. Dabrowski (PhD) Confluent Environmental Pty (Ltd) 7 St. Johns Street, Dormehlsdrift, George, 6529
SACNASP:	Pr. Sci. Nat. (Water Resources) – 114084
Date:	17 August 2024
Version:	Draft Final

confluent

Declaration of Specialist Independence

- I consider myself bound to the rules and ethics of the South African Council for Natural Scientific Professions (SACNASP);
- At the time of conducting the study and compiling this report I did not have any interest, hidden or otherwise, in the proposed development that this study has reference to, except for financial compensation for work done in a professional capacity;
- Work performed for this study was done in an objective manner. Even if this study results in views and findings that are not favourable to the client/applicant, I will not be affected in any manner by the outcome of any environmental process of which this report may form a part, other than being members of the general public;
- I declare that there are no circumstances that may compromise my objectivity in performing this specialist investigation. I do not necessarily object to or endorse any proposed developments, but aim to present facts, findings and recommendations based on relevant professional experience and scientific data;
- I do not have any influence over decisions made by the governing authorities;
- I undertake to disclose 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 a competent authority to such a relevant authority and the applicant;
- I have the necessary qualifications and guidance from professional experts in conducting specialist reports relevant to this application, including knowledge of the relevant Act, regulations and any guidelines that have relevance to the proposed activity;
- This document and all information contained herein is and will remain the intellectual property of Confluent Environmental. This document, in its entirety or any portion thereof, may not be altered in any manner or form, for any purpose without the specific and written consent of the specialist investigators.
- All the particulars furnished by me in this document are true and correct.

Dr. James Dabrowski (Ph.D., Pr.Sci.Nat. Water Resources; SACNASP Reg. No: 114084)

‘August 2024

EXECUTIVE SUMMARY

Outeniqua Game Farm (covering Farm 373 and 420) constructed a road that crosses the Ruiterbos River at multiple locations and upgraded an existing road crossing that has resulted in the creation of a small instream dam (OGF1) on the Ruiterbos River, north of Mossel Bay, Western Cape. These activities were undertaken without the necessary authorisation required in terms of the National Environmental Management Act (NEMA) and will require a Section 24G application. As part of the Section 24G application, the applicant will also apply for the construction of a new, larger instream dam (OGF2) on the Ruiterbos River. Flow in the river is irregular and non-perennial and the purpose of the dam is to capture a portion of the periodic peak flood flows for agricultural (irrigation and livestock) and domestic use on the farm. It is proposed that OGF1 will be rehabilitated in favour of the construction of OGF2.

The site visit confirmed that the river is confined to a well-defined channel with clearly discernible bed and banks (relatively incised in places). From a geomorphological perspective, the entire width of the active channel is dominated by bedrock and sand/gravel substrate (with occasional cobbles/boulders) and is consistent with a predominantly Transitional (Geozone C) to Upper Foothill zonation (or Geozone D). Transitional rivers are typically moderately steep rivers running along a confined valley, dominated by bedrock, with limited floodplain development. Narrow sand and gravel bars were present along lower gradient stretches which are more typical of Upper Foothill rivers. Water levels were very low at the time of the assessment and biotopes were dominated by shallow, slow flowing pools and occasional narrow shallow runs. Occasional narrow stretches of channelled valley bottom wetland habitat were observed along sand banks but were not continuous along the entire length of the river channel. In terms of classification, the river reach is considered to be primarily a river dominated by granite bedrock, with narrow, intermittent patches of channelled valley-bottom wetland habitat where sand banks have formed along gentler gradients.

The river has been impacted by upstream agriculture (abstraction of water and regulation of flows due to instream dams) and dense invasions of *Acacia mearnsii* along the riparian zone. These activities have resulted in modifications to river flows and channel morphology (eroded banks and incised channel). Instream habitat and biotopes (while of a relatively low diversity) are however relatively unaffected and representative of the natural geomorphological zonation of the river. The river reach is not considered important from a fish diversity perspective, and only the extralimital *Tilapia sparmanii* (introduced to the Western Cape) was observed. A survey of macroinvertebrates was conducted applying the South African Scoring System (SASS5). SASS scores are relatively low and are likely a reflection of water quality impacts from agriculture and low instream biotope diversity (dominated by relatively shallow pools in a bedrock and sand substrate).

While the Ruiterbos River is relatively impacted by agricultural abstraction and alien invasion along most of the length of the river, the instream habitat within the Outeniqua Game Farm is good. The river is scenic and apart from supporting aquatic biodiversity will provide habitat and refuge for a variety of terrestrial animal species. Ongoing efforts to clear alien invasives are commendable and have the potential to result in a long-term improvement in the general ecological condition of the river. While clearing of *A. mearnsii* has favoured the establishment of the non-native *C. clandestinus,* the lack of a dense canopy cover will hopefully facilitate the seeding and germination of indigenous species in the long-term. Impacts caused by the road crossings are considered to be minor and rehabilitation of the road is not considered necessary. The current OGF1 dam allows water to pass through a wall constructed from

gabions and baseflows in the river downstream of the wall were being maintained at the time of the visit. The impact of the dam on aquatic habitat is relatively small considering its size. Sediment that had been removed from the dam has however been dumped into the channel of the river downstream of the dam and must be removed as part of rehabilitation efforts.

Construction of a larger dam on the Ruiterbos River will impede flows (particularly base flows) and will have a High impact on aquatic biodiversity. Environmental authorisation of the dam should only be considered subject to the following conditions:

- A reserve determination study must be undertaken to estimate Ecological Flow Requirements required to maintain baseflows and a recommended ecological category (REC) downstream of the dam. The reserve study must be completed prior to the construction of the dam so that operational releases can be factored into the design of the dam;
- Irrigation and other water requirements must be accurately determined to ensure that abstraction of water is not excessive and meets the water demand for the farm;
- A comprehensive water balance (taking hydrological inflows and irrigation requirements into consideration) must be developed so as to determine an optimal dam size that will not store more water than is required to meet the water demand for the farm;
- Pumps used to abstract water from the dam must be fitted with calibrated flow meters with the purpose of ensuring that annual lawful water allocations are not exceeded; and
- An aquatic biomonitoring plan (minimum of SASS and habitat) must be implemented to ensure that the release of environmental flows is maintaining the aquatic ecosystem at the desired REC. The timing, frequency and substance of the monitoring plan must be determined by the reserve determination study.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

1.1 Project Background

Outeniqua Game Farm (OGF) (covering Farm 373 and 420) constructed a road that crosses the Ruiterbos River at multiple locations and upgraded an existing road crossing that has resulted in the creation of a small instream dam on the Ruiterbos River, north of Mossel Bay, Western Cape. These activities were undertaken without the necessary authorisation required in terms of the National Environmental Management Act (NEMA) or the National Water Act (NWA). The main aim of NEMA is to provide for co-operative governance by establishing decision-making principles on matters affecting the environment. In terms of the NEMA EIA regulations, the applicant is required to appoint an Environmental Assessment Practitioner (EAP) to undertake the EIA, as well as conduct the public participation process. The EIA regulations have identified activities that may result in substantial impacts to the environment. The regulations require that an environmental impact assessment process be undertaken for these activities and submitted to the relevant authority for consideration. Commencement with any of the listed activities prior to obtaining authorisation from the relevant authority is prohibited by these regulations and constitutes an offence. Unauthorised commencement or continuation of activities identified in terms of the Environment Impact Assessment Regulations can be rectified by means of an application to the Minister or relevant MEC, in terms of Section 24G of NEMA.

As part of the Section 24G application, the applicant will also apply for the construction of a new, larger instream dam on the Ruiterbos River. Flow in the river is irregular and non-perennial and the purpose of the dam is to capture a portion of the periodic peak flood flows for agricultural (irrigation and livestock) and domestic use on the farm. It is proposed that the small existing instream dam will be rehabilitated in favour of the construction of a new, larger instream dam.

1.2 Key Legislative Requirements

1.2.1 National Environmental Management Act (NEMA, 1998)

According to the protocols specified in GN 320 (Procedures for the Assessment and Minimum Criteria for Reporting on Identified Environmental Themes in Terms of Sections 24(5)(A) and (H) and 44 of the National Environmental Management Act, 1998, when Applying for Environmental Authorisation), assessment and reporting requirements for aquatic biodiversity are associated with a level of environmental sensitivity identified by the national web-based environmental screening tool (screening tool). An applicant intending to undertake an activity identified in the scope of this protocol on a site identified by the screening tool as being of:

- Very High sensitivity for aquatic biodiversity, must submit an Aquatic Biodiversity Specialist Assessment; or
- Low sensitivity for aquatic biodiversity, must submit an Aquatic Biodiversity Compliance Statement.

According to the protocol, prior to commencing with a specialist assessment a site sensitivity verification must be undertaken to confirm the sensitivity of the site as indicated by the screening tool:

- Where the information gathered from the site sensitivity verification differs from the screening tool designation of Very High aquatic biodiversity sensitivity, and it is found to be of a Low sensitivity, an Aquatic Biodiversity Compliance Statement must be submitted.
- Similarly, where the information gathered from the site sensitivity verification differs from the screening tool designation of Low aquatic biodiversity sensitivity, and it is found to be of a Very High sensitivity, an Aquatic Biodiversity Specialist Assessment must be submitted.

Given that the unauthorised activities have already occurred within a watercourse and that the new dam will be instream, the sensitivity of the site (in terms of Aquatic Biodiversity) is automatically considered to be **Very High**.

1.2.2 National Water Act (NWA, 1998)

The Department of Water & Sanitation (DWS) is the custodian of South Africa's water resources and therefore assumes public trusteeship of water resources, which includes watercourses, surface water, estuaries, or aquifers. The National Water Act (NWA) (Act No. 36 of 1998) aims to protect water resources, through:

- The maintenance of the quality of the water resource to the extent that the water resources may be used in an ecologically sustainable way;
- The prevention of the degradation of the water resource; and
- The rehabilitation of the water resource.

A watercourse means:

- A river or spring;
- A natural channel in which water flows regularly or intermittently;
- A wetland, lake or dam into which, or from which, water flows; and
- Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

No activity may take place within a watercourse unless it is authorised by the Department of Water and Sanitation (DWS). According to Section 21 (c) and (i) of the National Water Act, an authorization (Water Use License or General Authorisation) is required for any activities that impede or divert the flow of water in a watercourse or alter the bed, banks, course or characteristics of a watercourse. The regulated area of a watercourse for section 21(c) or (i) of the Act water uses means:

a) The outer edge of the 1 in 100-year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse of a river, spring, natural channel, lake or dam;
b) In the absence of a determined 1 in 100-year flood line or riparian area the area within 100m from the edge of a watercourse where the edge of the watercourse is the first identifiable annual bank fill flood bench (subject to compliance to section 144 of the Act); or
c) A 500 m radius from the delineated boundary (extent) of any wetland or pan.

The construction of the new dam is proposed to occur instream and therefore requires authorization through a Water Use License Application (WULA). The road crossings can be included in the same application.

1.3 Scope of Work

Based on the key legislative requirements listed above the scope of work for this report includes the following:

- Undertake a desktop study of relevant freshwater information for the site;
- Undertake a site visit to the study area;
- Delineate and classify the freshwater ecosystems affected by the road crossing and the construction of the dam;
- Determine the Present Ecological State (PES), functional importance and conservation value of the freshwater ecosystems that have been/will be affected by the road crossings and the construction of the dam;
- Describe and assess the significance of the potential impacts of the road crossing and dam on freshwater ecosystems;
- Provide a summary of the findings in the form of a Freshwater Ecology Impact Assessment Report; and
- Provide a plan to rehabilitate the existing instream dam.

2. METHODS

2.1 Desktop Assessment

A desktop assessment was conducted to contextualize the affected watercourse in terms of its local and regional setting, and conservation planning. An understanding of the biophysical attributes and conservation and water resource management plans of the area assists in the assessment of the importance and sensitivity of the watercourses, the setting of management objectives and the assessment of the significance of anticipated impacts. The following data sources and GIS spatial information were consulted to inform the desktop assessment:

- DWS spatial layers;
- National Freshwater Ecosystem Priority Areas (NFEPA) spatial layers (Nel et al., 2011);
- National Wetland Map 5 and Confidence Map (CSIR, 2018);
- Western Cape Biodiversity and Spatial Plan (WCBSP) for George (CapeNature, 2017); and
- Analysis of historical aerial photographs and satellite imagery with the aim assisting in establishing the former condition/state of the affected area.

2.2 Baseline Assessment

A site visit was conducted on the 28th of May and the 7th of August 2024, with the objective of identifying and classifying the watercourse affected by the road and dams, assessing biotic communities at the site, determining the Present Ecological State (PES) and Ecological

Importance and Sensitivity (EIS) of the watercourse, and assessing the impacts of historical and proposed future activities on the watercourse.

2.2.1 Watercourse Classification

Classification of watercourses is important as this determines the PES and EIS assessment methodologies that can be applied. Furthermore, classification of the watercourse provides a fundamental understanding of the hydrological and geomorphic drivers that characterise the watercourse and therefore assists in the interpretation of impacts to the watercourse. The watercourse was categorised into discrete hydrogeomorphic units (HGMs) based on its geomorphic characteristics, source of water and pattern of water flow through the watercourse. These HGMs were then classified according to Ollis et al. (2013).

2.2.2 Aquatic Biomonitoring

2.2.2.1 SASS5 Protocol

The SASS5 rapid bio-assessment method for rivers (Dickens and Graham, 2002) was used to evaluate the ecosystem health of the river at the proposed new dam site based on the absence or presence of sensitive and tolerant macroinvertebrate species. In summary, each family is rated between 1 to 15, based on their sensitivity to pollutants (1 indicating lowest sensitivity or highest tolerance to pollutants and 15 indicating highest sensitivity or lowest tolerance to pollutants). The sum of all the ratings per family for a particular sample is the SASS5 score. The number of different taxa is also taken into account as another measure of river condition. The Average Score Per Taxon (ASPT) is calculated by dividing the SASS5 score by the number of different taxa identified and is often the most meaningful metric.

Relevant aquatic biotopes were sampled using a standardised sweep-net (30 x 30 cm) protocol. Stones in current were sampled for a total of two minutes, placing the net downstream of the stones and agitating the substrate vigorously to dislodge macroinvertebrates into the net. Sediment habitats (gravel, sand and mud) and stones out of current were sampled for a total of one minute each by agitating the substrate and sweeping the net repeatedly through the disturbed area. A total length of 2 m of marginal aquatic vegetation was sampled by sweeping the net repeatedly in amongst or under vegetation hanging into the water. A total surface area of 2 m^2 of in-stream aquatic vegetation was sampled by sweeping the net repeatedly in amongst the vegetation. Macroinvertebrates collected from each biotope (stones, vegetation and gravel/sand/mud) were placed in an open tray of water and identified to family level. The total number of individuals per family was estimated through use of a grid marked on the bottom of the tray.

Available habitat biotopes (stones in and out of current, bedrock, gravel, sand, mud, instream vegetation and marginal vegetation in and out of current) were scored from 1 (very poor – low diversity) to 5 (highly suitable – wide diversity). The sum of the scores is expressed as a percentage of the total maximum score (45) and provides an indication of available habitat quality.

2.2.2.2 Fish sampling

A SAMUS 725M electro shocking device was used to sample specific riverine habitats (e.g. runs, riffles, rapids, shallow to medium depth pools, back waters etc.). Electro shocking commenced in the downstream component of the habitat. An electro-shocker passes an electric current between two electrodes placed in the water, and stunned fish are caught with a scoop net. Shocking progresses upstream, with the fish kept in a bucket of water until sampling of that particular habitat is completed. The fish are then identified, recorded and released back into their respective habitats.

2.2.3 Present Ecological State

An important factor that influences the diversity and abundance of aquatic communities is the condition of the surrounding physico-chemical habitat. Habitat loss, alteration, or degradation generally results in a decline in species diversity. The PES of the river was assessed using methods described in Appendix 1.

2.2.4 Ecological Importance and Sensitivity

The ecological importance of a watercourse is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. Ecological sensitivity 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; Milner 1994). Both abiotic and biotic components of the system are taken into consideration in the assessment of ecological importance and sensitivity. The EIS assessment methodology can be viewed in Appendix 2.

2.2.5 Impact Assessment

Development activities typically impact on the following important drivers of aquatic ecosystems:

- *Hydrology:* Impacts on hydrological functioning at a landscape level and across the site which can arise from changes to flood regimes and base flows and modifications to general flow characteristics, including change in the hydrological regime or hydroperiod of the aquatic ecosystem (e.g. seasonal to temporary or permanent; impact of over-abstraction or instream or off-stream impoundment of a wetland or river etc.);
- *Geomorphology:* This refers to the alteration of hydrological and geomorphological processes and drivers, and associated impacts to aquatic habitat and ecosystem goods and services primarily driven by changes to the sediment regime of the aquatic ecosystem and its broader catchment;
- *Modification of water quality:* This refers to the alteration or deterioration in the physical, chemical and biological characteristics of water within streams, rivers and wetlands, and associated impacts to aquatic habitat and ecosystem goods and services (e.g. due to increased sediment load, contamination by chemical and/or organic effluent, and/or eutrophication etc.);
- *Fragmentation:* Loss of lateral and/or longitudinal ecological connectivity due to structures crossing or bordering watercourses (e.g. road or pipeline crossing a wetland);
- *Modification of aquatic habitat:* This refers to the physical disturbance of in-stream and riparian aquatic habitat and associated ecosystem goods and services including the loss or degradation of all or part of any unique or important features associated with or within the aquatic ecosystem (e.g. waterfalls, springs, oxbow lakes, meandering or braided channels, peat soils, etc.)*;* and

- *Aquatic biodiversity:* Impacts on community composition (numbers and density of species) and integrity (condition, viability, predator prey ratios, dispersal rates, etc.) of the faunal and vegetation communities inhabiting the site.

Modifications to these drivers ultimately influence the PES and EIS of a watercourse. Accordingly, impacts to the watercourse were described and assessed based on their potential to modify each of the above-mentioned drivers of aquatic ecosystem health, using the PES and EIS of the watercourse as a baseline against which to assess impacts. The impact assessment methodology is described in the appendix to this report (Appendix 3).

3. ASSUMPTIONS & LIMITATIONS

- With ecology being dynamic and complex, there is the likelihood that some aspects (some of which may be important) may have been overlooked;
- This assessment is based on the findings of a visual assessment of the site combined with available desktop resources. This study was not informed by detailed hydraulic, hydrological, faunal or floral assessments;
- The PES and EIS assessments undertaken are largely qualitative assessment tools and thus the results are open to professional opinion and interpretation. An effort has been made to substantiate all claims where applicable and necessary; and
- The assessment of impacts relies on an understanding of the conditions prior to the commencement of the unlawful activities. As the activities have already occurred, this assessment relied on a combination of desktop analysis of historical imagery and observed on-site verifications of soil profiles and topographical features. It is possible that the relatively low resolution of historical aerial imagery may not clearly reflect the ecological condition and attributes of freshwater features on site. As such, while every effort was made to use reliable information, the final assessment ultimately relied on expert opinion, informed by the weight of available evidence.

4. STUDY SITE

The Outeniqua Game Farm comprises of two properties, Farm 378 and Farm RE/420, located within quaternary catchment K10D of the Kromme Primary Catchment (Figure 1). The two properties cover a combined area of 1277 ha in extent and are located in the foothills of the Outeniqua Mountains. The Ruiterbos River originates from the mountains and runs north to south along the boundary of the two properties and joins the Palmiet River to form the Brandwag River which terminates at the Great Brak Estuary. Numerous, small instream farm dams are located in the upper most reaches of the river and its catchment, where a mixture of dryland and irrigated pastures are farmed (with small areas of macadamias and avocado). The properties fall within the Southern Coastal Belt (Ecoregion Level 1: 22) which is located from 0 to 500 m a.m.s.l. and is characterized by undulating plains and low hills of moderate relief. Terrain throughout the properties consists of flat to gentle sloping plains at higher altitudes interspersed with very steep valleys along the Ruiterbos River and its tributaries. Rainfall occurs all year round, with peaks in winter and mean annual rainfall of approximately 500 mm. Summers are warm (mean daily maximum temperature of 22 to 28 ºC) and winters are mild to cold (mean daily maximum temperature of 16 to 20 ºC).

Within the Outeniqua Game Farm, the Ruiterbos River is mapped as a non-perennial river associated with a channelled valley-bottom wetland (Figure 2). The river runs along a steeply confined valley and is fed by several non-perennial rivers draining from the east and west. The activities assessed in this report include the following:

- A road running along the length of the Ruiterbos River which crosses the river at multiple locations (X1 to X8);
- A small instream dam (constructed without authorisation) – referred to as OGF1;
- A larger new dam (proposed to be constructed pending environmental and water use authorisation) – referred to as OGF2.

OGF2 is proposed to be located a short distance downstream from the existing dam (Figure 2).

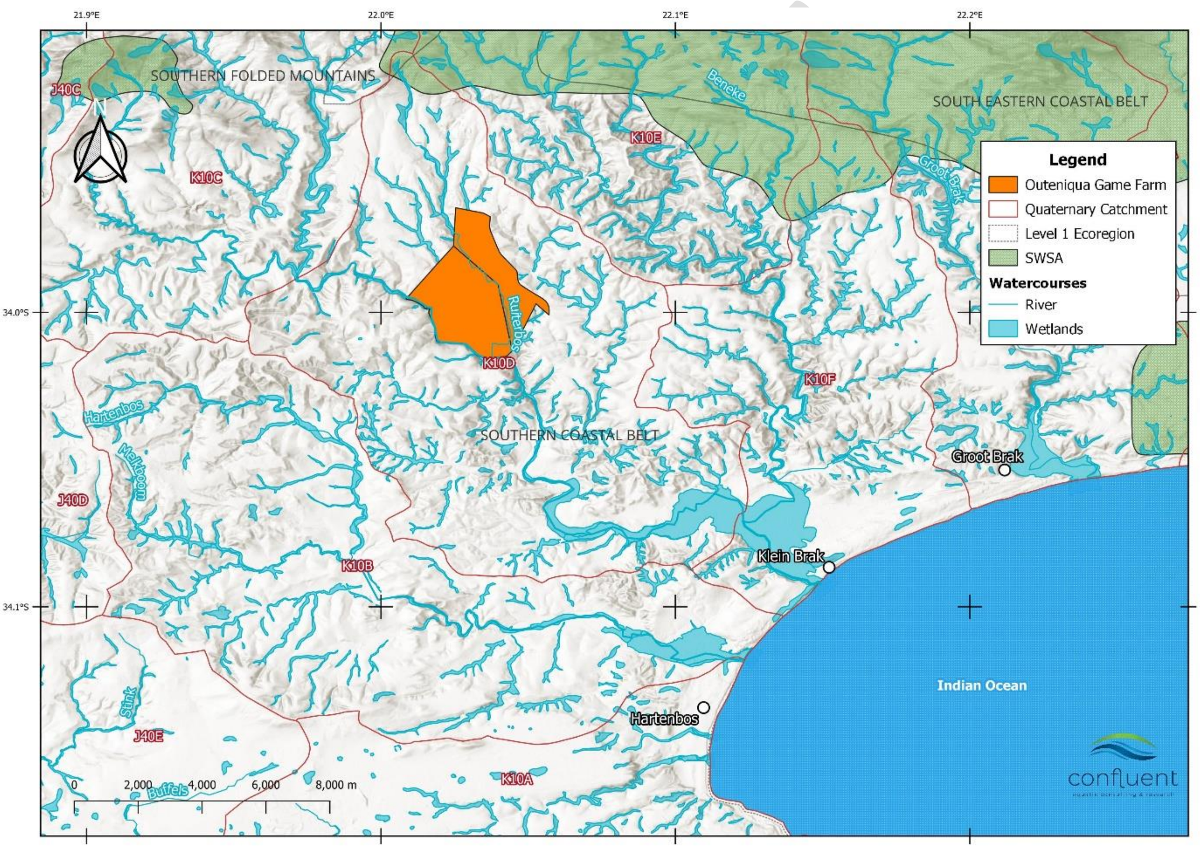

Figure 1: Location of the Outeniqua Game Farm in quaternary catchment K10D.

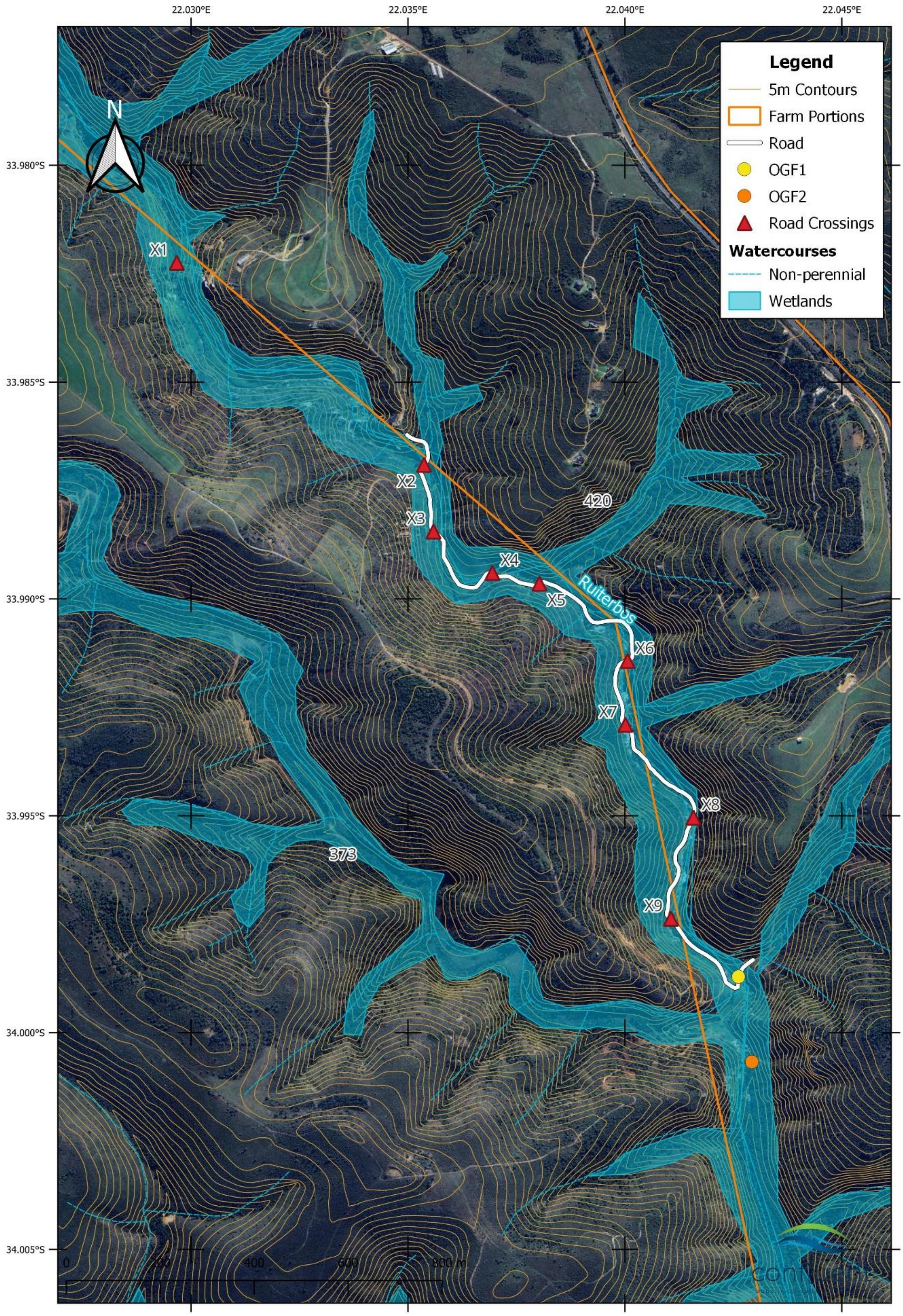

Figure 2: Map showing watercourses affected by historical and proposed activities on the Ruiterbos River running through the Outeniqua Game Farm.

4.1 National Freshwater Ecosystem Priority Areas (NFEPA)

The property lies in sub-quaternary catchment (SQC) 9121 (Figure 3). According to the National Freshwater Ecosystem Priority Atlas, this SQC has not been assigned a FEPA category. The SQC is therefore not considered important from a freshwater conservation perspective and is not located upstream of any FEPA SQCs.

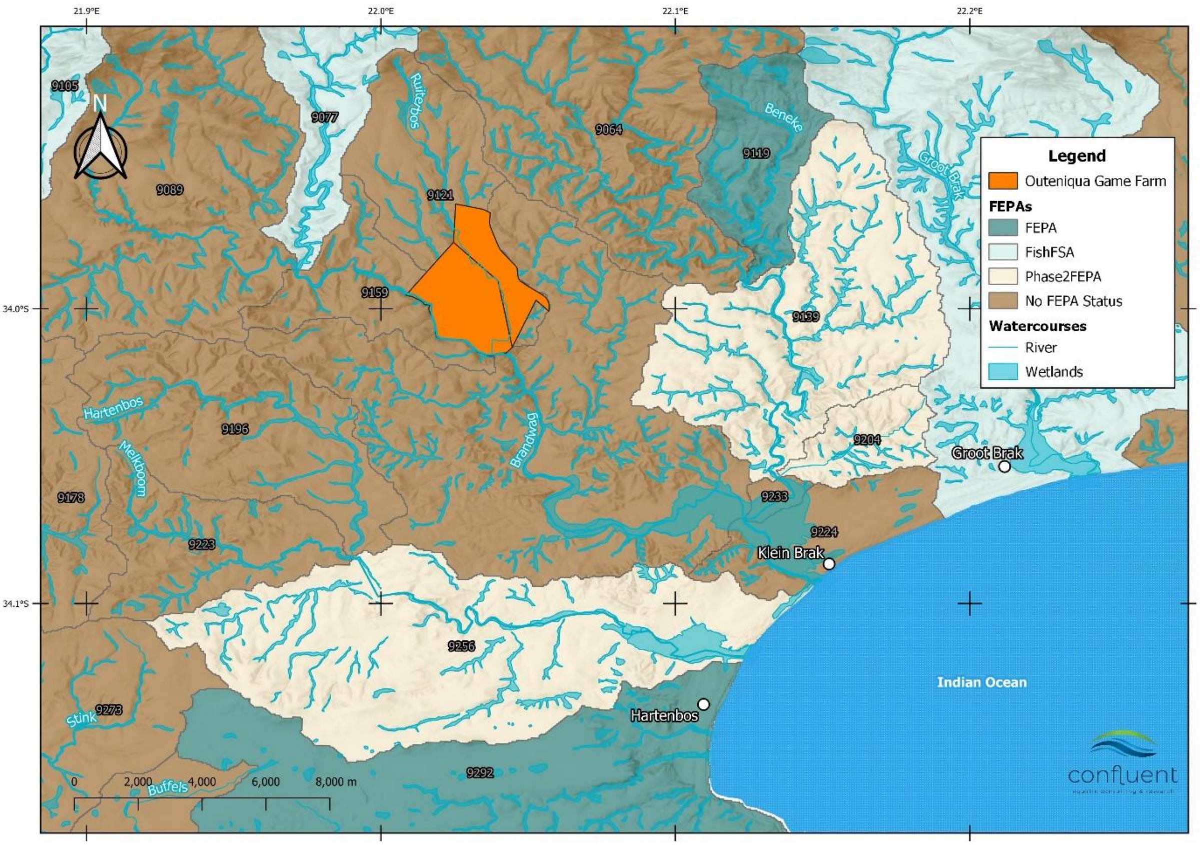

Figure 3: Map of the Outeniqua Game Farm in relation to FEPAs.

4.2 Western Cape Biodiversity Spatial Plan (WCBSP)

The main purpose of a biodiversity spatial plan is to ensure that the most recent and best quality spatial biodiversity information can be accessed and used to inform land use and development planning, environmental assessments and authorisations, natural resource management and other multi-sectoral planning processes. The WCBSP plan achieves this by providing a map of terrestrial and freshwater areas that are important for conserving biodiversity pattern and ecological processes – these areas are called Critical Biodiversity Areas (CBAs) and Ecological Support Areas (ESAs).

According to the WCBSP for Mossel Bay, the entire length of the Ruiterbos River running through both properties is mapped as an aquatic Critical Biodiversity Area (CBA1) wetland (Figure 4). CBA1 aquatic features are in a largely natural condition and are required to meet biodiversity targets, for species, ecosystems or ecological processes and infrastructure (Table 1). Management objectives are to maintain in a natural or near-natural state with no further loss of habitat.

Table 1: WCBSP categories and associated management objectives.

Category	Description	Management Objectives
CBA1	Areas in a natural condition that are required to meet biodiversity targets, for species, ecosystems or ecological processes and infrastructure.	Maintain in a natural or near-natural state, with no further loss of habitat. Degraded areas should be rehabilitated. Only low-impact, biodiversity-sensitive land-uses are appropriate.

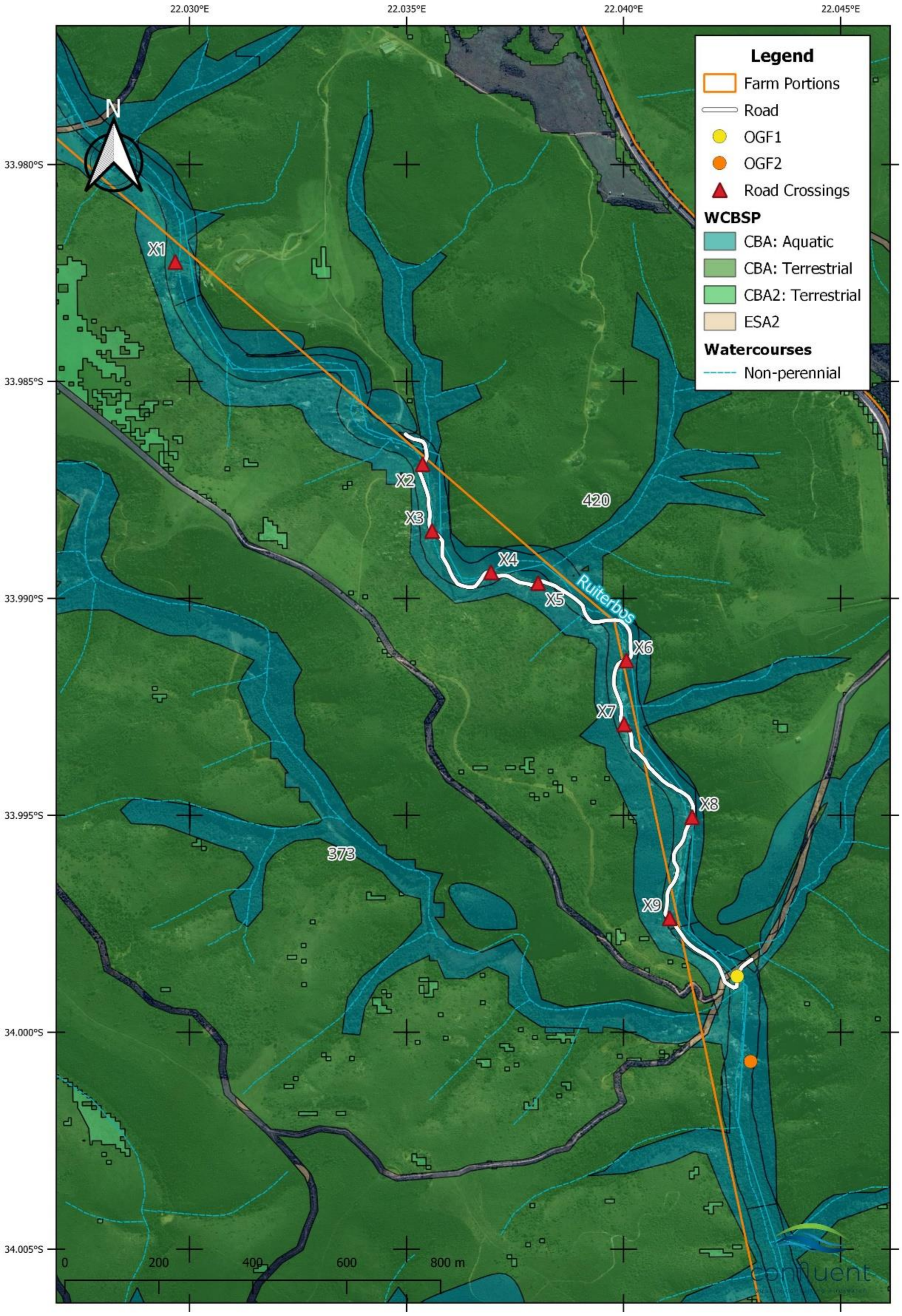

Figure 4: Map of the dam crossings in relation to the Western Cape Biodiversity Spatial Plan (WCBSP).

4.3 Resource Quality Objectives

The classification of water resources and development of Resource Quality Objectives (RQOs) for the Breede-Gouritz Catchment Management Area was finalised in 2018. The Ruiterbos River falls within quaternary catchment K10D, which falls within the G14 Groot Brak Integrated Unit of Analysis (IUA). The Water Resource Class for this IUA is III, indicating sustainable minimal protection and high utilization. Quaternary K10D catchment does not fall within a priority resource unit, therefore no specific RQOs have been set for this catchment area. The Target Ecological Category (TEC) for the catchment has been set as a D (Largely Modified), which indicates a highly impacted river with a low level of protection for high utilisation for socio-economic development.

4.4 Aquatic Biodiversity

The Freshwater Biodiversity Information System (FBIS) (an open-access platform hosting freshwater biodiversity records for South Africa) was consulted with a view to obtaining any historical records of aquatic biodiversity for the Ruiterbos River (FBIS, 2022). The river and its catchment area has been poorly sampled (Figure 5) and no records for macroinvertebrates, fish or amphibians are available (only diatom records are available).

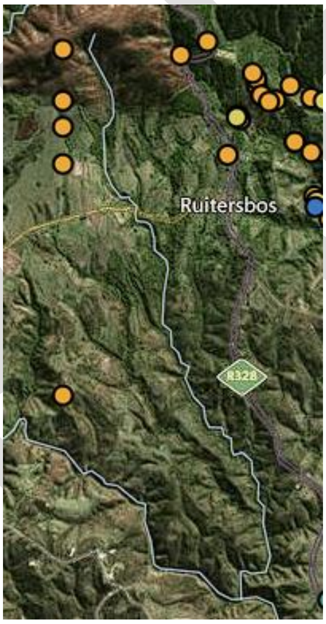

Figure 5: Clip of a map from the FBIS database illustrating the lack of freshwater biodiversity records for the Ruiterbos River.

5. SITE ASSESSMENT

The length of the Ruiterbos River stretching from road crossing X1 down to the proposed location for OGF2 was assessed (see Figure 2).

5.1 Watercourse Classification

The section of the Ruiterbos River running through the Outeniqua Game Farm runs through a steep, confined valley. The National Wetland Map version 5 (CSIR, 2018) indicates that the entire length of the river is associated with a channelled valley-bottom wetland habitat (Figure 2). These wetlands are typically associated with rivers and develop adjacent to the active channel of the river. The wetlands are sustained by a combination of subsurface interflow from the valley slopes, lateral seepage from the active channel and flooding during periodic high flow events (Figure 6).

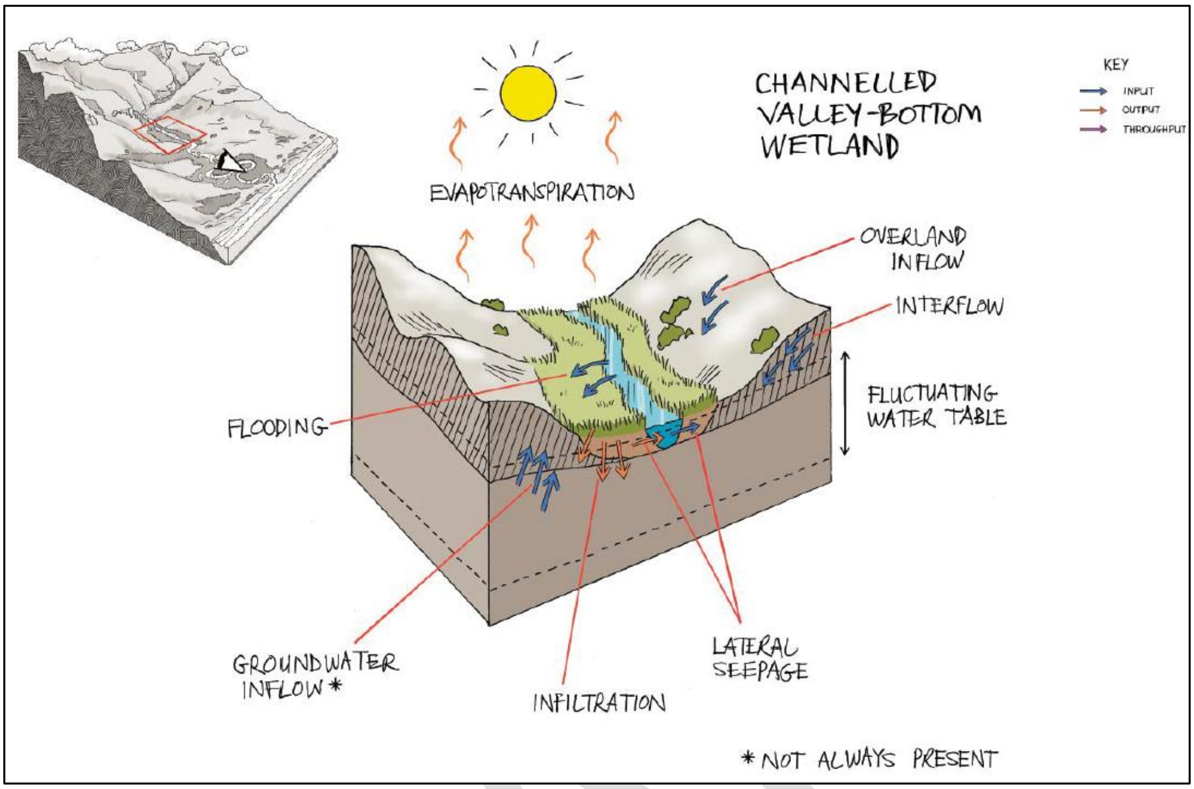

Figure 6: Diagram indicating dominant hydrological factors influencing channelled valley-bottom wetland (Ollis et al. 2013).

The site visit confirmed that the river is confined to a well-defined channel with clearly discernible bed and banks (relatively incised in places). From a geomorphological perspective, the entire width of the active channel is dominated by bedrock and sand/gravel substrate (with occasional cobbles/boulders) and is consistent with a predominantly Transitional (Geozone C) to Upper Foothill zonation (or Geozone D) (Figure 7 and Ollis et al., 2013). Transitional rivers are typically moderately steep rivers running along a confined valley, dominated by bedrock, with limited floodplain development. Narrow sand and gravel bars were present along lower gradient stretches which are more typical of Upper Foothill rivers. Water levels were very low at the time of the assessment and biotopes were dominated by shallow, slow flowing pools and occasional narrow shallow runs. Occasional narrow stretches of channelled valley bottom wetland habitat were observed along sand banks, but were not continuous along the entire length of the river channel. A variety of wetland plant species were observed (see Figure 8). In terms of classification, the river reach is considered to be primarily a river dominated by granite bedrock, with narrow, intermittent patches of channelled valley-bottom wetland habitat where sand banks have formed along gentler gradients.

Figure 7: Photographs of the Ruiterbos River showing channelled valley-bottom wetland habitat along sections of the active channel of the river (A to C); and typical granite bedrock and sand sections that were most common along the river reach (D to F).

Figure 8: Wetland vegetation observed in wetland sections, including Cyperus thunbergii (A); Berula thunbergii (B); Juncus lymatophyllus (C); Isolepis prolifera (D); Cyperus textilis (E); and Juncus effusus (F).

5.2 Water Quality

In-situ water quality measurements were taken using a hand-held multi-parameter water quality meter (HANNA HI98194). Water was clear (high clarity) with very low turbidity. While flow can be best described as trickle base flow, the water was well oxygenated, indicating a low organic load, as would be expected of a stream close to its mountain source (Table 2). Conductivity and pH are higher than would be expected for a southern Cape stream, which are generally characterised by low conductivity and acidic pH. Streams that run through areas with granite bedrock tend to have lower conductivity because granite is composed of more inert materials that do not ionize (dissolve into ionic components) when washed into the water.

The conductivity measurement therefore indicates elevated concentrations of salts (most likely from upstream agricultural activities) which can also account for the increase in pH (in case of elevated base cations such as calcium and sodium).

Table 2: In-situ water quality measurements taken at the proposed location of OGF2

Parameter	Measurement
Temperature	21.2 ºC
Dissolve Oxygen	9.95 mg/L
pH	7.16
Conductivity	88.3 mS/m
Clarity	80 cm

5.3 Aquatic Biodiversity

5.3.1 Macroinvertebrates

Instream biotopes were relatively limited. Substrate was dominated by bedrock and coarse sand to fine gravel and the main biotope present was shallow, very slow flowing pools, ranging from 5 to 40 cm in depth. Cobble riffle (stone in current) habitat was very poorly represented and runs were generally very shallow chutes over bedrock connecting pools. Instream vegetation was very limited to small patches *Persecaria sp.* and marginal vegetation was sparse. Overall instream habitat (whilst representative of the geomorphological river zonation) is fairly limited in terms of diversity as is reflected in the biotope score (53 % - Table 3). In total 21 taxa were observed (Table 4), which included a relatively high proportion of air breathing taxa (i.e. Hemipterans and Gyrinidae beetles). These taxa are typically abundant in pools where slow-moving currents do no not favour rapid respiration across gill surfaces typically required by other aquatic macroinvertebrate taxa. Gomphid dragonfly larvae and Naucorid bugs were abundant in gravel habitat. Families favouring high flow conditions (e.g. Ephemerotera, Plecoptera and Trichoptera) comprised a low proportion of taxa. The total SASS score was 92 with an ASPT of 4.4 which is a relatively low score (Table 4) – see Appendix 4 for the comprehensive SASS scoring sheet. Elevated conductivity levels (together with other contaminants such as pesticides and fertilisers used in agriculture) are likely to partly explain this score, however, the limited habitat diversity and seasonal flow regime is also a contributing factor. Most importantly, the SASS results provide a baseline against which to monitor future downstream impacts of the proposed OGF2 dam.

Table 3: Summary of biotope scores recorded at the proposed OGF2 dam site.

Metric	Score
Stones in Current	2
Stones out of Current	1
Bedrock	5
Aquatic Vegetation	1
Marginal Vegetation in Current	2
Marginal Vegetation out of Current	1
Gravel	4
Sand	5
Mud	3
Biotope Score	**24 (53 %)**

Table 4: Summary of SASS scores recorded at the proposed OGF2 dam site

Metric	Score
SASS Score	92
Number of Taxa	21
Average Score per Taxon	4.4

5.3.2 Fish

An approximate 200 m stretch of river habitat was sampled in the vicinity of the OGF2 dam site. Habitat for fish is very limited and is restricted to deeper pools (~ 40 cm depth) where cover (in the form of rock overhangs and marginal aquatic vegetation) was available. No fast-flowing run or riffle habitat was present. Only one fish species was collected – *Tilapia sparmanii.* This species is tolerant of a wide range of habitats but has a preference for slow flowing pools or standing water. The species was relatively abundant in such pools and adults and juveniles were observed. The natural distribution of this species is from the Orange River and southern KwaZulu-Natal northwards (Skelton, 2004). The species has been introduced to the Western Cape Distribution in the Western Cape where it is considered extralimital (i.e. occurs outside of its natural distribution).

Given the seasonal nature of river flows, rheophilic species favouring fast flowing water are unlikely to occur along the river reach. Marginal, lentic habitat availability during the dry season will only likely to be suitable for hardy species such as *T. sparmanii.* No other records of any fish species have been recorded for the Ruiterbos River and given the FEPA status for the catchment area, is unlikely to be an important river reach for conservation of fish species.

Figure 9: Specimen of T. sparmanii collected during the fish survey.

5.4 Summary of Unauthorised Activities

5.4.1 Road along Ruiterbos River

Vegetation was cleared to create a road along the Ruiterbos River in 2019 (Figure 10). This also coincided with clearance of dense stands of Black Wattle (*Acacia mearnsii*) which appear to have invaded the entire length of the river channel. During the site visit, evidence of *A.*

mearnsii invasion along the steeper slopes adjacent to the river was apparent and clearance of the invasion is ongoing (Figure 11). Since then, kikuyu (*Cenchrus clandestinus*) grass has taken over along the banks of the river and revegetated the entire length of the road, to the extent that the road is now defined by a single jeep-track running along the length of the river. At one specific location (near crossing X3) an accumulation of woody debris (comprising of large, felled trees) has created a partial obstruction along the eastern bank of the river channel which appears to have caused visible bank erosion along the opposite bank (presumably due to deflection of flood energy into the opposite bank) - Figure 11.

The road crosses the river at several location along the river. The crossings are unprotected drifts directly across the riverbed (most often on bedrock substrate, but also occasionally over cobble substrate) - Figure 12. At one crossing (X1) cement tracks have been constructed down each bank leading down to the river. Road crossings have not resulted in any impedance or diversion of flow. In some instances (X7 and X9) multiple entry/exit points to/from the river have resulted in unnecessary additional disturbance to the riverbank. No signs of erosion were observed at road crossing points.

Figure 10: Historical aerial images showing dense invasion of A. mearnsii along the Ruitersbos River (2018), clearance of vegetation for a road along the river (2019), and the present day (2024).

Figure 11: Photographs showing recent stands of A. mearnsii that have been felled along the valley slope of the Ruiterbos River - active stands of A. mearnsii can be seen in the background (left); and accumulation of felled alien invasives obstructing flow and causing erosion along the opposite bank (right).

Figure 12: Photographs showing low level drifts crossing the Ruiterbos River.

5.4.2 OGF2 (Existing Dam)

Historical imagery indicated the presence of a road crossing the Ruiterbos River at the dam location from at least 2005 (Figure 13). The river crossing and current instream dam location is first visible in 2017, when clearing of vegetation occurred (most likely *A. mearnsii*). In 2017 it appears as if a low-level concrete crossing was present. Over time the road has been maintained along its existing alignment and footprint, maintaining an inundated area upstream of the road. The river experiences significant flooding and over time it appears as if the crossing may have been damaged and replaced by a low-level dirt crossing, a section of which would become inundated during higher flow periods (e.g. 2020). A notable change occurred in 2024, when the road crossing was visibly upgraded and the inundated area upstream of the road was enlarged. The site visit confirmed the presence of a road supported by gabion baskets which essentially acts as small dam/weir (Figure 14). The gabion baskets are porous and together with pipes through the road, water does pass through the road, maintaining flow below the road. The gabion baskets had experienced damage during recent flood events and will most likely require maintenance in the near future. Sediment that had been excavated from upstream of the road (to enlarge the dam basin) had been deposited in the river downstream of the road. General disturbance to the bed and banks and widening of the channel immediately downstream of the road was visible.

Figure 13: Historical imagery indicating the presence of the road crossing in 2005, a small area of inundation upstream of the road that varied in size over time (from 2019 to 2022) and the enlarged dam in 2024.

Figure 14: Photographs of the road crossing and small instream dam upstream of the road (red arrows indicating sediment dumped in the channel of the Ruiterbos River).

5.5 OGF2 (New Dam)

The proposed location of the new OGF2 dam is situated further downstream from the existing OGF1 dam (Figure 2). At the time of writing the size of the dam had not yet been confirmed and no dam designs were available. Based on preliminary discussions with the landowner, the dam is likely to be a minimum of 80 000 m^3. The dam is therefore likely to present a significant barrier to instream flows (particularly low base flows) and will result in inundation of river habitat.

5.6 Present Ecological State (PES)

The PES assessment of the river considered the entire length of the Ruiterbos River running from its source and through the Outeniqua Game Farm. As described previously, the upper most reaches of the Ruiterbos River are dominated by agriculture which is associated with numerous small instream farm dams and abstraction of water for irrigation. Base flows running through the properties have therefore been reduced. The channel banks are incised and eroded in places, most likely due to historical invasion by *A. mearnsii*. Water quality measurements indicate relatively high conductivity, which is likely due to upstream agricultural activities. Apart from these modifications, instream habitat is in a relatively good ecological state. The most significant impacts are associated with riparian habitat. The entire length of the river reach had historically been heavily invaded by mainly *Acacia mearnsii.* Clearing of invasives has taken place right up to the banks of the river and vegetation has been replaced by kikuyu (*Cenchrus clandestinus*). The lack of a functional riparian zone has compromised the protection of the channel against peak flood flows and will most likely contribute to the erosion and incision of the channel banks. The PES of the River is **D – Largely Modified** (Table 5).

Table 5: Instream and riparian IHI scores for the Ruiterbos River.

Modification	Scores
Instream Habitat	
Water abstraction	**12 –** High rates of abstraction for irrigation of pastures and orchards upstream
Flow modification	**12 –** Flow regulated by numerous small instream dams located higher up in the catchment
Bed modification	**5 –** Minor alterations to sediment regime (slight increase).
Channel modification	**12 –** Incised channel due to alien invasive species (upstream) and lack of functional riparian zone (Outeniqua Game Farm).
Physico-chemical modification	**10 –** Agricultural runoff (salts, fertilisers and pesticides)
Inundation	**4 –** None
Alien macrophytes	**0** – None
Alien aquatic fauna	**0** - None
Rubbish dumping	**5 –** None
Instream IHI score	**61 (C – Moderately Modified)**
Riparian Habitat	
Vegetation removal	**12** – Riparian habitat largely absent from Outeniqua Game Farm. Intact along broader river reach
Invasive vegetation	**16** – High levels of invasion (*A. mearnsii*) in broader catchment area. Previous invasion along the riparian zone in the Outeniqua Game Farm has been cleared – this has however been largely replaced by *Cenchrus clandestinus* (trees and shrubs largely absent).
Bank erosion	**12 –** Erosion caused by alien plant invasives (historical) and lack of functional riparian zone (current).
Channel modification	**10 –** Incised channel caused by alien plant invasives (historical) and lack of functional riparian zone (current).
Water abstraction	**3** – Minimal impacts on riparian vegetation.
Inundation	**0 –** None
Flow modification	**0** – Moderately affected.
Physico-chemical modification	**0 –** None
Riparian IHI Score	**38 (E – Seriously Modified)**
Combined Score	**50 (D – Largely Modified)**

5.7 Ecological Importance & Sensitivity (EIS)

The Ruiterbos River is a relatively small non-perennial river characterised by seasonal flows. It provides important diversity of habitat at a local scale, but given its flow characteristics, offers low potential for hosting endangered or unique biota. Considering its size and geomorphological zonation, the river is relatively sensitive to changes in flow and water quality.

In terms of conservation importance, the river is an aquatic CBA and is regarded as important for meeting biodiversity targets at a provincial scale. Overall, the river is considered as important at a local scale (**Moderate EIS -** Table 6).

Table 6: EIS scores for the Ruiterbos River running through the Outeniqua Game Farm.

Determinant	Score
Presence of Rare & Endangered Species	**1** – Low probability of rare or endangered taxa.
Populations of Unique Species	**1 –** Low probability of unique species.
Intolerant Biota	**2** – Moderate proportion of biota is expected to be dependent on flowing water for the completion of their life cycle.
Species/Taxon Richness	**2** - Moderate diversity of fauna and flora expected on a local scale.
Diversity of Habitat Types or Features	**2** – Geomorphological zonation offers limited habitat diversity, but is important at a local scale.
Refuge value of habitat types	**2** – Important at a local scale.
Sensitivity of habitat to flow changes	**3** – Relatively small Upper Foothill river – sensitive to flow changes.
Sensitivity to flow related water quality changes	**3** – Relatively small Upper Foothill river – low assimilative capacity and sensitive to changes in water quality.
Migration route for instream and riparian biota	**1** – Headwater catchment – offers limited connectivity. Not important as a migration route.
Protection Status	**2** – Aquatic CBA – important at a provincial scale
EIS Score	**2 (Moderate Importance and Sensitivity)**

6. IMPACT ASSESSMENT

6.1 Historical Activities

Impact 1: Disturbance of bed and banks caused by construction of road along the Ruiterbos River

Road crossings are two-track, low-level crossings over a combination of bedrock and sand substrate. Permanent structures are limited to short sections of concrete track on the bank of the river at crossing X1. Multiple entry/exit points to/from the river at X7 and X9 have resulted in unnecessary additional disturbance to the riverbank, however none of the crossings that were assessed have resulted in any impedance of flow and have not resulted in any erosion of the bank.

	Without Mitigation	With Mitigation
Intensity	Low	Very low
Duration	Ongoing	Ongoing
Extent	Very Limited	Very limited
Probability	Unlikely	Unlikely
Significance	**-30: Negligible**	**-27: Negligible**
Reversibility	High	High
Irreplaceability	Low	Low
Confidence	High	High

Mitigation:

- Entry/exit points at each crossing must be restricted to a single track to limit disturbance to the bank and the potential for erosion to occur; and
- Road crossings must be routinely inspected. Any bank sections which have become exposed and appear vulnerable to erosion should be immediately protected in an appropriate manner so as to prevent or arrest the erosive process before further damage to the channel can occur;

Impact 2: Removal of riparian habitat caused by construction of road along the Ruiterbos River

Based on the site assessment and historical imagery, it appears as if the riparian zone was dominated by *A. mearnsii,* although it is uncertain whether any indigenous species may have been present in amongst the invasion. Dense, woody invasions of *A. mearnsii* typically degrade channel habitat by constraining flood events to the river channel which contributes to increased bank erosion. Dense canopies also shade out stabilising understorey vegetation which also contributes to erosion of the channel. It is therefore most likely that current bank incision observed along the river is largely related to the historical invasion along the river. Currently the riparian zone is dominated by *C. clandestinus* and trees and shrubs are largely absent from the riparian zone. Shallow rooted riparian species do not stabilise banks well and the channel will most likely be susceptible to continued erosion in the future.

Impacts associated with historic and current condition of the riparian zone are similar and, assuming the riparian zone was historically dominated by *A. mearnsii*, the transformation to a grass dominated riparian zone represents a relatively low impact. It is however likely that some indigenous species were cleared, which, if left in-situ, would have contributed to a more rapid regeneration of the riparian zone.

	Without Mitigation	With Mitigation
Intensity	Moderate	Low
Duration	Ongoing	Ongoing
Extent	Limited	Limited
Probability	Likely	Unlikely
Significance	**-60: Minor**	**-33: Negligible**
Reversibility	High	High
Irreplaceability	Low	Low
Confidence	High	High

Mitigation:

- Alien invasive species must continue to be controlled along the river. Felled trees must be removed from the banks and must not be dumped in the active channel of the river.
- Passive regeneration together with active planting of the riparian zone must be encouraged. Passive regeneration allows indigenous species to naturally re-seed and re-establish along the banks. This process must be encouraged wherever possible and vehicle access must be restricted to use of the road only so as to avoid disturbance to new seedlings. Recommended plant species for active planting can be viewed in Table 7.

Impact 3: Impendence of flow caused by the gabion road structure crossing the Ruiterbos River

Construction of the gabion road crossing, together with excavation of sediment from the channel upstream of the road has impeded flow in the Ruiterbos River and created a small instream dam, allowing the landowner to abstract water from the river. The gabion wall does however allow water to flow through the wall and base flows below the crossing were maintained at the time of the site visit. It is however unknown whether this base flow would be maintained when the water in the dam drops below a certain level.

	Without Mitigation	With Mitigation
Intensity	Low	Negligible
Duration	Ongoing	Immediate
Extent	Limited	Very limited
Probability	Certain	Highly unlikely
Significance	**-77: Moderate**	**-3: Negligible**
Reversibility	High	High
Irreplaceability	Low	Low
Confidence	High	High

Mitigation:

- The existing dam must be rehabilitated as a condition of approval for the new larger dam (see Rehabilitation Plan).

Impact 4: Impact of OGF1 dam on river habitat

Excavation of sediment from upstream of the dam wall has created a small dam basin in the river, converting habitat from a natural lotic (flowing) system to a lentic (stagnant) system. This represents a very small section of habitat relative to the length of the entire river reach.

	Without Mitigation	With Mitigation
Intensity	Low	Negligible
Duration	Ongoing	Immediate
Extent	Limited	Very limited
Probability	Unlikely	Highly unlikely
Significance	**-33: Negligible**	**-3: Negligible**
Reversibility	High	High
Irreplaceability	Low	Low
Confidence	High	High

Mitigation:

- The existing dam must be rehabilitated as a condition of approval for the new larger dam (see Rehabilitation Plan)

Impact 5: Impact of dumping excavated sediment in the Ruiterbos River

Excavated sediment has been dumped in the watercourse downstream of the gabion wall which has smothered aquatic habitat. Future flood flows could potentially be diverted into the opposite bank (causing erosion of the bank) or could disperse the dumped sediment over a larger area, smothering a greater area of habitat.

	Without Mitigation	With Mitigation
Intensity	High	Very low
Duration	Short term	Immediate
Extent	Limited	Very limited
Probability	Likely	Unlikely
Significance	**-50: Minor**	**-12: Negligible**
Reversibility	High	High
Irreplaceability	Low	Low
Confidence	High	High

Mitigation:

- The sediment must be removed from the watercourse (see Rehabilitation Plan).

6.2 New Dam - Construction Phase Impacts

Impact 6: Inundation of river habitat caused by construction of a new instream dam

Construction of a new instream dam will result in a larger area of inundation, permanently transforming a section of river habitat from a lentic to a lotic system. Macroinvertebrate communities along the river reach will be altered. In terms of fish species only *T. sparmanii* was collected during sampling. These fish favour slow flowing pools and are unlikely to be negatively affected by the inundation of the river. The extent of inundation represents a small percentage of the entire length of the river and the spatial extent the impact is therefore very limited.

	Without Mitigation
Intensity	High
Duration	Ongoing
Extent	Very Limited
Probability	Certain
Significance	**-84 (Moderate)**
Reversibility	High
Irreplaceability	Low
Confidence	High

Mitigation:

- Cannot be mitigated.

Impact 7: Disturbance and pollution of aquatic habitat caused by construction of the dam.

Construction of an instream dam wall will require that construction vehicles and machinery will need to access the river which can result in:

- Physical disturbance of aquatic habitat (beyond the footprint of the dam) and
- Pollution through leaks and spills of hydrocarbons (i.e. fuel and oil from construction vehicles and machinery) and other construction materials (e.g. cement, paint etc.) and
- Mobilisation of sediment due excavation of the bed and banks and operation of construction vehicles in the watercourse

	Without Mitigation	With Mitigation
Intensity	High	Moderate
Duration	Short term	Short term
Extent	Limited	Limited
Probability	Almost Certain	Probably
Significance	**-60 (Minor)**	**-36: Minor**
Reversibility	High	High
Irreplaceability	Low	Low
Confidence	High	High

Mitigation:

- Construction of the dam must occur during the dry season (i.e. December to January or June to July);
- Working areas must be clearly demarcated and no vehicle access or disturbance must take place outside of demarcated areas;
- Rehabilitate and naturalise areas beyond the development footprint, which have been affected by the construction activities, using indigenous grass species;
- Vehicles must be restricted to travelling only on designated roadways to limit the ecological footprint of the proposed development activities;
- Restrict vehicle access to the river to single points that are clearly demarcated;

- Excavators and all other machinery and vehicles must be checked for oil and fuel leaks daily. No machinery or vehicles with leaks are permitted to work in the river;
- No fuel storage, refuelling, vehicle maintenance or vehicle depots to be allowed within 30 m of the edge of the river;
- Ensure that all stockpiles are well managed and have measures such as berms and hessian sheets implemented to prevent erosion and sedimentation. Stockpiles must be located more than 30 m from the edge of the river;
- Contractors used for the project should have spill kits available to ensure that any fuel or oil spills are cleaned and disposed correctly;
- Adequate sanitary facilities and ablutions must be provided for all personnel throughout the project area. Use of these facilities must be enforced (these facilities must be kept clean so that they are a desired alternative to the surrounding vegetation) and must be routinely serviced; and
- No dumping of construction or waste material is permitted. All construction and waste materials must be removed from the river valley and correctly disposed.

6.3 Operational Phase Impacts

Impact 8: Impact of reduced instream flows on instream habitat and aquatic biota.

Instream aquatic biota are adapted to specific temporal variations in flow volumes. Dams disrupt the volume of flows and timing of flood events, which in turn influences downstream habitat quality and availability. Construction of a dam will impound flows and alter the natural flow regime of the river downstream of the dam. Base flows are most likely to be affected and the volume and duration of base flow events is expected to be significantly reduced. Given that the river flows are seasonal, reduction in base flows can have a significant impact on downstream biota. Flow conditions downstream of the dam are likely to become highly intermittent, with low potential for maintenance of aquatic macroinvertebrate and fish communities over longer periods. It is likely that pools along the river (which are currently sustained by prolonged periods of base flow) would dry up and only opportunistic macroinvertebrate species (with rapid life-cycles) would be able to tolerate such flow conditions. Downstream flows will generally be restricted to high and peak flood events when the dam periodically reaches the full supply level and overflows. Overall, an approximately 2 km stretch of the Ruiterbos River will be affected by the dam.

	Without Mitigation	With Mitigation
Intensity	Very High	Moderate
Duration	Permanent	Permanent
Extent	Local	Local
Probability	Certain	Almost Certain
Significance	**-112: High**	**-84: Moderate**
Reversibility	High	High
Irreplaceability	Low	Low
Confidence	High	High

Mitigation:

- A reserve determination study must be undertaken to estimate Ecological Flow Requirements required to maintain baseflows and a recommended ecological category (REC) downstream of the dam. The reserve study must be completed prior to the construction of the dam so that operational releases can be factored into the design of the dam.
- Irrigation and other water requirements must be accurately determined to ensure that abstraction of water is not excessive and meets the water demand for the farm;
- A comprehensive water balance (taking hydrological inflows and irrigation requirements into consideration) must be developed so as to determine an optimal dam size that will not store more water than is required to meet the water demand for the farm;
- Pumps used to abstract water from the dam must be fitted with calibrated flow meters with the purpose of ensuring that annual lawful water allocations are not exceeded;

- An aquatic biomonitoring plan (minimum of SASS and habitat) must be implemented to ensure that the release of environmental flows is maintaining the aquatic ecosystem at the desired REC. The timing, frequency and substance of the monitoring plan must be determined by the reserve determination study.

Impact 9: Impact of reduced sediment transport on instream habitat and aquatic biota.

Substrate along the riverbed is dominated by bedrock and coarse sediment (coarse sand and fine gravel). Dams act as a barrier to sediment transport and trap sediment which will likely lead to a reduction in sediment supply and a modification to the quality and diversity of instream habitat downstream of the dam. Shortage of sediment supply downstream of the dam can also lead to accelerated erosion of the bed and banks of downstream watercourses, which ultimately leads to degradation of habitat quality over time.

	Without Mitigation
Intensity	High
Duration	Permanent
Extent	Local
Probability	Almost certain
Significance	**-90: Moderate**
Reversibility	High
Irreplaceability	Low
Confidence	High

Mitigation:

- Cannot be mitigated.

Impact 10: Fragmentation of aquatic habitat caused by construction of OGF2.

The dam creates a barrier preventing movement of biota upstream and downstream of the wall. This most significantly affects fish species. *T. sparmanii* are not migratory and are adapted to living in slow flowing lentic systems and are therefore unlikely to be affected. The longfin eel (*Anguilla mossambica*) was not collected during sampling on the river but is common along rivers throughout the Southern Cape. This species is catamadromous and breed at sea but spend most of their adult life in freshwater systems. They therefore migrate from the sea to rivers and vice versa and dams pose significant barriers to migration routes. There are no major impoundments downstream of the proposed dam site and it is possible that this species may migrate upstream and inhabit pools along the length of the river. While dam walls do pose significant barriers to migration, this species is known to navigate up high barriers

A fish ladder can be incorporated into the design of the dam wall which is designed to allow fish eels to migrate over dam walls. This option is however likely to add expense to the dam design and construction and would need to be designed by a suitably qualified specialist. Given that the river reach is not considered to be important for fish diversity and the fact that *A. mossambica* is not threatened, can navigate up significant obstacles and is not confirmed to be present in the river, the construction of a fish ladder is not considered to be a justifiable mitigation measure.

	Without Mitigation
Intensity	High
Duration	Ongoing
Extent	Local
Probability	Probably
Significance	**-56: Minor**
Reversibility	High
Irreplaceability	Low
Confidence	High

7. REHABILITATION PLAN

7.1 Rehabilitation Goals

A condition of the construction of the new dam is that the existing OGF1 dam must be removed and the channel rehabilitated. The plan assumes that the construction of OGF2 will not inundate the existing road crossing and OGF1.

7.2 Rehabilitation Actions

7.2.1 Removal of Sediment Previously Excavated from the Riverbed

As observed in the site assessment, sediment that was excavated from the riverbed upstream of the road (to enlarge the storage capacity) has been dumped in the watercourse downstream of the road crossing. This is a valuable source of material for rehabilitation and is at risk of being lost during flood events.

- An excavator may be used to remove sediment from river;
- The sediment must be removed from the watercourse as soon as possible and stockpiled well outside of the floodline for use in rehabilitation of the river channel once the dam wall has been removed. The stockpile must be covered and protected from rainfall and erosion to prevent loss of material;
- Care must be taken not to widen or deepen the channel during the removal of the dumped material. The depth of the bed and width of the channel must be continuous with the channel further downstream.

7.2.2 Removal of Dam Wall

- An excavator may be used to remove the dam wall;
- Dam removal must take place during the dry season (generally June to July or December to January) so as to minimise the potential of flooding whilst working in the watercourse. Weather forecasts must be consulted with aim of the ensuring a minimum 3-day window of low (< 10 %) percent likelihood of rainfall.
- The water level must be drawn down as much as possible prior to removal of the dam wall. A single opening must be made in the wall to allow water to drain out in a controlled manner.
- Once the water level has receded, the gabion wall can be removed using common excavation methods and earth-moving equipment. The wall must be removed in a systematic fashion, with the excavator operating from the surface of the existing road crossing, moving backwards along the road as material is removed from the watercourse.
- All gabion and road materials, including rock, wire baskets and concrete/cement structures MUST be removed from the site and disposed of at an appropriate waste disposal facility. No road materials or gabion baskets may be dumped in the watercourse or stockpiled adjacent to the watercourse.
- Removal of the dam wall must be overseen by and appropriately qualified Environmental Control Officer (ECO) or an aquatic ecologist.

7.2.3 Replacement and Stabilisation of Soil

Once the dam wall has been removed, the natural channel of the river must be restored to enable the conveyance of flowing water without causing erosion of the bed and banks of the river. The channel must be reshaped such that the embankment slopes gently towards the channel and is consistent with the natural channel of the river. Stockpiled sediment can be used to reshape the banks (see Section 7.2.1). The following precautions must be undertaken:

- Construction vehicle parking and equipment stores must be located at least 100 m from the demarcated area to prevent fuel and material spills from entering the watercourse;
- Access by vehicles must be in and out on one road only to reduce the area of disturbance;
- The wetland areas upstream of the dam must be demarcated as 'No-go Areas' for people and vehicles.
- The banks must be reshaped and sloped to the natural site contours, avoiding the creation of ditches and cuts which channel water flow and cause erosion. The shape/contours/dimensions of the banks must be continuous with the undisturbed section of wetland upstream of the dam.
- Reshaping of the channel must take place during the dry season (generally June to July or December to January) so as to minimise the potential of flooding whilst working in the watercourse. Weather forecasts must be consulted with aim of the ensuring a minimum 3-day window of low (< 10 %) percent likelihood of rainfall
- The final reshaped channel must be independently assessed by an ECO or aquatic ecologist and signed off as complete.

7.2.4 Revegetation

Revegetation of the slopes must be undertaken to provide stability to the soil and prevent erosion. This is the primary aim in the short-term, while improving biodiversity of the site would be a longer-term aim. Without successful revegetation, the slopes will undoubtedly erode in areas, causing ongoing degradation of the watercourse. It is therefore crucial that if the decision is made for the excavated area to be rehabilitated that a detailed rehabilitation plan be followed using the following mitigation measures:

- Seed the slopes and stream bed with an indigenous fynbos grass mix and cover with a light mulch;
- Nail in overlapping soil saver matting to protect the soil (see Appendix 5);
- Revegetated slopes must be actively monitored to ensure a dense cover of > 80% of grass. Gaps should be actively re-seeded;
- A combination of active and passive revegetation must take place in the 10 m buffer zone: Active = planting recommended indigenous species, and Passive = not disturbing indigenous plants that naturally germinate (See Table 7 for suitable plant species);
- Alien vegetation must be actively removed before it becomes established when it can either be hand-pulled or removed with a tree popper. NO heavy machinery can be used for the purpose of alien removal;

- Revegetation of the buffer and previously excavated area must be monitored 6-monthly by an ECO or Aquatic Ecologist until such time that revegetation of the banks is considered satisfactory;
- Monitoring should also take place by the land-owner following heavy rainfall to identify and proactively address erosion before it can progress too severely;
- Eroded areas of the steep banks must be refilled with topsoil, reseeded with grass mix, covered with a light mulch and protected with soil saver mats; and
- Monitoring of the site is recommended to ensure that rehabilitation efforts are successful and that problematic areas are attended to effectively and pro-actively.

Table 7: List of approporiate plant species.

Species Name	Common Name	Planting density guide / 75 m^2
Trees		
Ekebergia capensis	Cape Ash	1
Halleria lucida	Tree fuchsia	3
Osteospermum moniliferum	Bitou	3
Searsia undulata	Kuni-bush	1
Protea neriifolia	Pink ice	1
Buddleja salviifolia	Sagewood	1
Tarchonanthus littoralis	Coastal camphorbush	2
Virgilia oroboides	Keurboom	1
Shrubs		
Agathosma recurvifolia	Boegoe	2
Cyclopia subternata	Vleitee	5
Helichrysum petiolare	Licorice plant	5
Phylica ericoides	Hardeblaar	2
Psoralea axillaris	Violet-flash fountainbush	1
Watsonia angusta	Narrow watsonia	2
Watsonia fourcadei	Forked watsonia	2
Watsonia pillansii	Orange watsonia	2
Selago corymbosa	Stiff bitterbush	2
Otholobium acuminatum	Longsepal dottypea	1
Pelargonium cordifolium	Heartleaf storksbill	3
Grasses		
Themeda triandra	Red grass	2 / m^2
Eragrostis capensis	Heart-seed love grass	
Eragrostis curvula	Weeping love grass	
Pennisetum macrourum	Riverbed grass	

7.3 Monitoring Plan

Monitoring the progress, successes and failures of rehabilitation efforts is important. Seasonal variation and local weather events (e.g. rainfall, wind, drought) may influence rehabilitation efforts and can be used as triggers to follow up and track progress.

7.3.1 Revegetation

- Ensure there is adequate vegetative cover to prevent erosion in riparian buffer zones, especially during months when higher rainfall is expected;

- Where temporary vegetation has been planted, follow up to determine whether indigenous vegetation is establishing, and begin active revegetation with indigenous plants if necessary. This should be done following one growing season; and
- Fixed point photography of sites where revegetation has been implemented should be used to track ground cover.

7.3.2 Alien clearing

In order to maintain the integrity of the channel and riparian habitat it is important that alien invasive plant species are not allowed to re-establish along the channel:

- Routine inspection of the channel banks must take place (every six months) to do follow-up control of the establishment of alien invasive plant species. Frequent inspection should allow alien plants species to be removed by hand pulling; and
- In the event that hand-pulling is not possible, the cut and stump method is recommended.

7.3.3 River Channel

- Subsequent to the reinstatement of the channel, frequent spot checks should be carried out after rainfall events to ensure that the stability of the channel bed and bank is such that erosion is prevented;
- Regular maintenance such as removal of debris in the channel should be carried out to ensure there is no flow blockage or constriction which could cause erosion or washout. Debris removal should be carried out by hand to prevent destabilization of the channel; and
- Any bank sections which have become exposed and appear vulnerable to erosion should be immediately protected in an appropriate manner so as to prevent or arrest the erosive process before further damage to the channel can occur.

8. CONCLUSION

The Ruiterbos River has been impacted by upstream agriculture (abstraction of water and regulation of flows due to instream dams) and dense invasions of *Acacia mearnsii* along the riparian zone. These activities have resulted in modifications to river flows and channel morphology (eroded banks and incised channel). Instream habitat and biotopes (while of a relatively low diversity) are however relatively unaffected and representative of the natural geomorphological zonation of the river. The river reach is not considered important from a fish diversity perspective, and only the extralimital *Tilapia sparmanii* (introduced to the Western Cape) was observed. SASS scores are relatively low and are likely a reflection of water quality impacts from agriculture and low instream biotope diversity (dominated by relatively shallow pools in a bedrock and sand substrate).

While the Ruiterbos River is relatively impacted by agricultural abstraction and alien invasion along most of the length of the river, the instream habitat within the Outeniqua Game Farm is good. The river is scenic and apart from supporting aquatic biodiversity will provide habitat and refuge for a variety of terrestrial animal species. Ongoing efforts to clear alien invasives are commendable and have the potential to result in a long-term improvement in the general ecological condition of the river. While clearing of *A. mearnsii* has favoured the establishment of the non-native *C. clandestinus,* the lack of a dense canopy cover will hopefully facilitate the seeding and germination of indigenous species in the long-term. Impacts caused by the road crossings are considered to be minor and rehabilitation of the road is not considered necessary. The current OGF1 dam allows water to pass through a wall constructed from gabions and baseflows in the river downstream of the wall were being maintained at the time of the visit. The impact of the dam on aquatic habitat is relatively small considering its size. Sediment that had been removed from the dam has however been dumped into the channel of the river downstream of the dam and must be removed as part of rehabilitation efforts.

Construction of a larger dam on the Ruiterbos River will impede flows (particularly base flows) and will have a High impact on aquatic biodiversity. This is not aligned to the CBA objectives for the river. Environmental authorisation of the dam should therefore only be considered subject to the implementation of the following mitigation measures:

- A reserve determination study must be undertaken to estimate Ecological Flow Requirements required to maintain baseflows and a recommended ecological category (REC) downstream of the dam. The reserve study must be completed prior to the construction of the dam so that operational releases can be factored into the design of the dam.
- Irrigation and other water requirements must be accurately determined to ensure that abstraction of water is not excessive and meets the water demand for the farm;
- A comprehensive water balance (taking hydrological inflows and irrigation requirements into consideration) must be developed so as to determine an optimal dam size that will not store more water than is required to meet the water demand for the farm;
- Pumps used to abstract water from the dam must be fitted with calibrated flow meters with the purpose of ensuring that annual lawful water allocations are not exceeded;
- An aquatic biomonitoring plan (minimum of SASS and habitat) must be implemented to ensure that the release of environmental flows is maintaining the aquatic ecosystem at the desired REC. The timing, frequency and substance of the monitoring plan must be determined by the reserve determination study; and
- The implementation and operation of the EFR must be audited on a routine basis for the operational life of the dam.

9. REFERENCES

CapeNature (2017). *2017 WCBSP Mossel Bay [Vector] 2017*. Available from the Biodiversity GIS website, downloaded on 26 March 2019.

Duthie, A. (1999). IER (Floodplain Wetlands) Determining the Ecological Importance and *Sensitivity (EIS) and Ecological Management Class (EMC).* Resource Directed Measures for Protection of Water Resources: Wetland Ecosystems. Department of Water Affairs and Forestry.

Freshwater Biodiversity Information System (FBIS). 2022. Downloaded from https://freshwaterbiodiversity.org on 17 August 2024.

Kleynhans, C.J. (1996). A qualitative procedure for the assessment of the habitat integrity status of the Luvuvhu River (Limpopo system, South Africa) Journal of Aquatic Ecosystem Health 5:41-54 1996.

Kleynhans, C.J. (1999). Resource Directed Measures for Protection of Water Resources: River Ecosystems. R7: Assessment of Ecological Importance and Sensitivity.

Milner, A.M. (1994). System recovery. In: Calow P and Petts GE (eds.): The rivers handbook. Vol. 2. Blackwell Scientific Publications. London.

Nel, J.L., Murray, K.M., Maherry, A.M., Petersen, C.P., Roux, D.J., Driver, A., Hill, L., van Deventer, H., Funke, N., Swartz, E.R., Smith-Adao, L.B., Mbona, N., Downsborough, L. and Nienaber, S. (2011). *Technical Report for the National Freshwater Ecosystem Priority Areas project.* WRC Report No. 1801/2/11. Water Research Commission, Pretoria, South Africa.

Ollis, D.J., Snaddon, C.D., Job, N.M. and Mbona, N. (2013). *Classification System for Wetlands and other Aquatic Ecosystems in South Africa. User Manual: Inland Systems.* SANBI Biodiversity Series 22. South African National Biodiversity Institute, Pretoria

Resh, V.H., Brown, A.P., Covich, M.E., Gurtz, H.W., Li, G.W., Minshall, S.R., Reice, A.L., Sheldon, J.B., Wallace and Wissmar, R.C. (1988). The role of disturbance theory in stream ecology. Journal of the North American Benthological Society. 7: 433-455.

Skelton, P.H. (2012). A complete guide to the freshwater fishes of southern Africa. Struik Publishers, Cape Town.

APPENDIX 1: INDEX OF HABITAT INTEGRITY

Index of Habitat Integrity (IHI; Kleynhans, 1996). The IHI was regarded as the most appropriate method for assessing riverine habitats as it is not dependent on flow in the watercourse and, therefore, produces results that are directly comparable across perennial and non-perennial systems. The IHI was developed as a rapid assessment of the severity of impacts on criteria affecting habitat integrity within a river reach. Instream (water abstraction; flow modification; bed modification; channel modification; physico-chemical modification; inundation; alien macrophytes; rubbish dumping) and riparian (vegetation removal, invasive vegetation, bank erosion, channel modification, water abstraction, inundation, flow modification, physico-chemistry) criteria are assessed as part of the index. Each of the criteria are given a score (from 0 to 25, corresponding to no and very high impact, respectively – Table 8) based on their degree of modification, along with a confidence rating based on the level of confidence in the score.

Weighting scores are used to assess the extent of modification for each criterion (*x*):

$$Weighted\ Score = \frac{IHI_x}{25} \times Weight_x$$

Where;

- IHI = rating score for the criteria (Table 8);
- 25 = maximum possible score for a criterion; and
- Weight = Weighting score for the criteria (Table 9).

Table 8: Descriptive classes for the assessment of habitat modifications (Kleynhans, 1996)

Impact Class	Description	Score
None	No discernible impact, or the modification is located in a way that has no impact on habitat quality, diversity, size and variability.	0
Small	The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability are also very small.	1-5
Moderate	The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability is limited.	6-10
Large	The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size and variability. Large areas are, however, not influenced.	11-15
Serious	The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area are affected. Only small areas are not affected.	16-20
Critical	The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section are influenced detrimentally.	21-25

Table 9: Criteria and weights used for the assessment of instream and riparian zone habitat integrity

Instream Criteria	Weight	Riparian Zone Criteria	Weight
Water abstraction	14	Indigenous vegetation removal	13
Flow modification	13	Exotic vegetation encroachment	12
Bed modification	13	Bank erosion	14
Channel modification	13	Channel modification	12
Water quality	14	Water abstraction	13
Inundation	10	Inundation	11
Exotic macrophytes	9	Flow modification	12
Exotic fauna	8	Water quality	13
Solid waste disposal	6		
TOTAL	**100**		**100**

The estimated impacts of all criteria calculated this way are summed, expressed as a percentage and subtracted from 100 to arrive at an assessment of habitat integrity for the instream and riparian components, respectively. An IHI class indicating the present ecological state of the river reach is then determined based on the resulting score (ranging from Natural to Critically Modified – Table 10).

Table 10: Index of habitat integrity (IHI) classes and descriptions

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

<u>Reference:</u>

Department of Water Affairs and Forestry (DWAF) (2007). Manual for the assessment of a Wetland Index of Habitat Integrity for South African floodplain and channelled valley bottom wetland types by M. Rountree (ed); C.P. Todd, C. J. Kleynhans, A. L. Batchelor, M. D. Louw, D. Kotze, D. Walters, S. Schroeder, P. Illgner, M. Uys. and G.C. Marneweck. Report no. N/0000/00/WEI/0407. Resource Quality Services, Department of Water Affairs and Forestry, Pretoria, South Africa

APPENDIX 2: ECOLOGICAL IMPORTANCE & SENSITIVITY (RIVERS)

The ecological importance and sensitivity (EIS) of the watercourse was assessed using a method developed by Kleynhans (1999). In summary, several biological and aquatic habitat determinants are assigned a score ranging from 1 (low importance or sensitivity) to 4 (high importance or sensitivity). These determinants include the following:

- **Biodiversity support:**
  - Presence of Red Data species;
  - Presence of unique instream and riparian biota;
  - Use of the ecosystem for migration, breeding or feeding.
- **Importance in the larger landscape:**
  - Protection status of the watercourse;
  - Protection status of the vegetation type;
  - Regional context regarding ecological integrity;
  - Size and rarity of the wetland types present;
  - Diversity of habitat types within the wetland.
- **Sensitivity of the watercourse:**
  - Sensitivity of watercourse to changes in flooding regime;
  - Sensitivity of watercourse to changes in low flow regime, and
  - Sensitivity to water quality changes.

The median value of the scores for all determinants is used to assign an EIS category according to Table 11.

Table 11: Ecological importance and sensitivity categories. Interpretation of average scores for biotic and habitat determinants.

Ecological Importance and Sensitivity Category (EIS)	Range of Median	Recommended Ecological Management Class
Very high: Quaternaries/delineations 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.	>3 and <=4	A
High: Quaternaries/delineations 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.	>2 and <=3	B
Moderate: Quaternaries/delineations that are considered to be unique on a provincial or local scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are usually not very sensitive to flow modifications and often have a substantial capacity for use	>1 and <=2	C
Low/marginal: Quaternaries/delineations 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.	>0 and <=1	D

Reference:

Duthie, A. (1999). IER (Floodplain Wetlands) Determining the Ecological Importance and Sensitivity (EIS) and Ecological Management Class (EMC). Resource Directed Measures for Protection of Water Resources: Wetland Ecosystems. Department of Water Affairs and Forestry.

APPENDIX 3: IMPACT ASSESSMENT METHODOLOGY

Individual impacts for the construction and operational phase were identified and rated according to criteria which include their intensity, duration and extent. The ratings were then used to calculate the consequence of the impact which can be either negative or positive as follows:

Consequence *= type x (intensity + duration + extent)*

Where type is either negative (i.e. -1) or positive (i.e. 1). The significance of the impact was then calculated by applying the probability of occurrence to the consequence as follows:

Significance *= consequence x probability*

The criteria and their associated ratings are shown in Table 12.

Table 12: Categorical descriptions for impacts and their associated ratings

Rating	Intensity	Duration	Extent	Probability
1	Negligible	Immediate	Very limited	Highly unlikely
2	Very low	Brief	Limited	Rare
3	Low	Short term	Local	Unlikely
4	Moderate	Medium term	Municipal area	Probably
5	High	Long term	Regional	Likely
6	Very high	Ongoing	National	Almost certain
7	Extremely high	Permanent	International	Certain

Categories assigned to the calculated significance ratings are presented in Table 13.

Table 13: Value ranges for significance ratings, where (-) indicates a negative impact and (+) indicates a positive impact

Significance Rating	Range	
Major (-)	-147	-109
Moderate (-)	-108	-73
Minor (-)	-72	-36
Negligible (-)	-35	-1
Neutral	0	0
Negligible (+)	1	35
Minor (+)	36	72
Moderate (+)	73	108
Major (+)	109	147

Each impact was considered from the perspective of whether losses or gains would be irreversible or result in the irreplaceable loss of biodiversity of ecosystem services. The level of confidence was also determined and rated as low, medium or high (Table 14).

Table 14: Definition of reversibility, irreplaceability and confidence ratings.

Rating	Reversibility	Irreplaceability	Confidence
Low	Permanent modification, no recovery possible.	No irreparable damage and the resource isn't scarce.	Judgement based on intuition.
Medium	Recovery possible with significant intervention.	Irreparable damage but is represented elsewhere.	Based on common sense and general knowledge
High	Recovery likely.	Irreparable damage and is not represented elsewhere.	Substantial data supports the assessment

APPENDIX 4: SASS SCORE SHEET

Date (dd-mm-yr):	28-May-24		(dd.ddddd)	**Biotopes Sampled (tick & rate)**	Rating (1 - 5) / Time (min)
Site Code:	Ruitersbos River	Grid reference (dd mm ss.s) Lat: S		Stones In Current (SIC)	2
Collector/Sampler:		Long: E		Stones Out Of Current (SOOC)	1
River:	Ruitersbos River	Datum (WGS84/Cape):		Bedrock	5
Level 1 Ecoregion:		Altitude (m):		Aquatic Veg	1
Quaternary Catchment:	K10D	Zonation:	Upper Foothills	MargVeg In Current	2
	Temp (°C):	**Routine or Project? (circle one)**	Flow: Trickle	MargVeg Out Of Current	1
Site Description:	pH: 7.2	Project Name:	Clarity (cm): 80 cm	Gravel	4
	DO (mg/L): 10.0	Outeniqua Game Farm	Turbidity: Low	Sand	4
	Cond (mS/m): 88.3		Colour: Light Brown	Mud	4
	Riparian Disturbance:	Alien clearing with herbicide		Hand picking/Visual observation	0
	Instream Disturbance:			Biotope Score (%)	53

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	B	B		B	Blepharoceridae (Mountain midges)	15				
ANNELIDA						Gerridae* (Pond skaters/Water striders)	5		A		A	Ceratopogonidae (Biting midges)	5				
Oligochaeta (Earthworms)	1	A			A	Hydrometridae* (Water measurers)	6					Chironomidae (Midges)	2	B	B	B	B
Hirudinea (Leeches)	3					Naucoridae* (Creeping water bugs)	7			B	B	Culicidae* (Mosquitoes)	1				
CRUSTACEA						Nepidae* (Water scorpions)	3					Dixidae* (Dixid midge)	10				
Amphipoda (Scuds)	13					Notonectidae* (Backswimmers)	3		1		1	Empididae (Dance flies)	6				
Potamonautidae* (Crabs)	3	A			A	Pleidae* (Pygmy backswimmers)	4		B	B	B	Ephydridae (Shore flies)	3				
Atyidae (Freshwater Shrimps)	8					Veliidae/M...veliidae* (Ripple bugs)	5		A		A	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	B			B
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	1			1
EPHEMEROPTERA (Mayflies)						Ecnomidae	8					**GASTROPODA (Snails)**					
Baetidae 1sp	4					Hydropsychidae 1 sp	4	B		A	B	Ancylidae (Limpets)	6				
Baetidae 2 sp	6	B	A	A	B	Hydropsychidae 2 sp	6					Bulininae*	3				
Baetidae > 2 sp	12					Hydropsychidae > 2 sp	12					Hydrobiidae*	3				
Caenidae (Squaregills/Cainfles)	6	B	B	B	B	Philopotamidae	10	1			1	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	B			B	**Cased caddis:**						Thiaridae* (=Melanidae)	3				
Oligoneuridae (Brushlegged mayflies)	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
Polymitarcyidae (Pale Burrowers)	10					Calamoceratidae ST	11					**PELECYPODA (Bivalves)**					
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**					92
Calopterygidae ST,T (Demoiselles)	10					Leptoceridae	6					**No. of Taxa**					21
Chlorocyphidae (Jewels)	10					Petrothrincidae SWC	11					**ASPT**					4.4
Synlestidae (Chlorolestidae)(Sylphs)	8					Pisuliidae	10					**Other biota:**					
Coenagrionidae (Sprites and blues)	4	1	A	1	A	Sericostomatidae SWC	13										
Lestidae (Emerald Damselflies/Spreadwings)	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	A	1	1	A	**Comments/Observations:**					
Corduliidae (Cruisers)	8					Haliplidae* (Crawling water beetles)	5										
Gomphidae (Clubtails)	6	B	A	B	B	Helodidae (Marsh beetles)	12										
Libellulidae (Darters/Skimmers)	4	1	1	A	A	Hydraenidae* (Minute moss beetles)	8										
LEPIDOPTERA (Aquatic Caterpillars/Moths)						Hydrophilidae* (Water scavenger beetles)	5		1		1						
Crambidae (Pyralidae)	12					Limnichidae (Marsh-Loving Beetles)	10										
						Psephenidae (Water Pennies)	10										

APPENDIX 5: SOIL SAVER MATTING & REVEGETATION

Between the silt fences described in the section below, soil will be vulnerable to erosion and must be stabilised. A combination of temporary vegetation cover and soil matting will be used (Figure 17). The following steps must be taken:

- Lightly rake over the soil to create a uniform surface.
- Seed the areas between silt fences with a cover of weed-free grass mix consisting of rye grass, *Cynodon dactylon* and *Digitaria eriantha* purchased from a registered supplier (e.g. Agricol). These grasses will rapidly provide cover and stabilise the soil. The seeding rate should be 20 -30 kg/ha. Seed should be scattered as uniformly as possible to prevent clumping, and the silt fences should be avoided as seed will probably collect along these lines anyway.
- The seeded area must be covered in a light mulch (1-2 cm deep). This can consist of shredded woody material but must not be wood chips. Chipped alien vegetation is not suitable as it will contain seeds of alien vegetation.
- Cover the seeded and mulched slops with a rolled erosion control product (such as jute, coir or straw matting). Preferably a natural (vs. man-made), bio-degradable product should be used. The use of a jute geotextile called Soilsaver is recommended. It is available from Kaytech in Port Elizabeth and in Cape Town.

The role of the erosion control matting is not to provide long-term protection for slopes from erosion, but to protect the soil surface until vegetation can establish and become the permanent stabilising feature. The slope should be seeded and mulched, and then covered with erosion control matting which will remain in place until the vegetation has established. Matting should be overlapped by about 10cm and secured using wooden stakes along the edges. Terminal ends of the matting can also be staked or buried in an anchor trench.

Figure 15: Images of installed soil saver matting and silt fences several weeks after installation

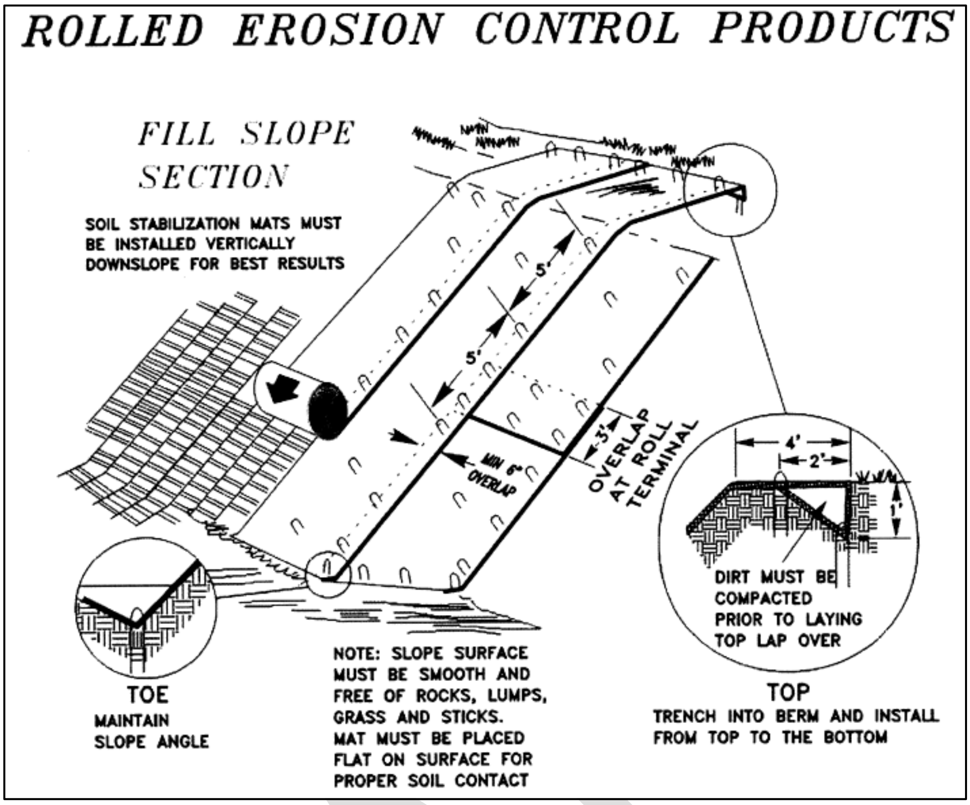

Figure 16: Example of methods recommended to install erosion control matting on sloping areas that require revegetation (Source: Department of Environmental Protection, West Virginia