Establishment of Almond and Pomegranate Orchards on Portion 4 of Farm 172 Kellershoogte.

Section 24G - Freshwater Assessment Report

For:

Cape EAPrac

By:

Confluent Environmental

October 2021

confluent
aquatic consulting & research

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- 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;
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1. INTRODUCTION

1.1 Project Background

The applicant (Mooiplaas Trust) constructed a pipeline to transfer water from two new boreholes located on Portion 19 of Farm 170 Gamtoosberg to Portion 4 of Farm 172 Kellershoogte, to irrigate almond trees and pomegranates. A section of the pipeline crossed a non-perennial tributary of the Kandelaars River on Portion 3 of Farm 172 Kellershoogte. The applicant also prepared historically cultivated fields for planting of these trees. In doing so, a small non-perennial drainage line draining hills to the south of the fields was ploughed through and transformed into agricultural fields. The above-mentioned activities commenced without the necessary authorisation as required by the National Environmental Management Act (NEMA) and the National Water Act (NWA). As a result of these unlawful activities, a Section 24G rectification process has been initiated by the Department of Environmental Affairs & Development Planning (DEA&DP) under the National Environmental Management Act (NEMA; Act No. 107 of 1998).

1.2 Key Legislative Requirements

1.2.1 National Environmental Management Act (NEMA, 1998)

The main aim of the National Environmental Management Act, 1998 (Act 107 of 1998) (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.

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 installation of the boreholes, the pipeline crossing the non-perennial tributary of the Kandelaars River and the section of the intermittent drainage lost as a result of the preparation of fields all fall within the regulated area of a watercourse and are all Section 21 (c) or (i) water uses. As a license application is being submitted for the abstraction of water from the two new boreholes located on Portion 19 of Farm 170, all additional 21 (c) and (i) water uses must be included as part of the Water Use License Application (WULA).

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;
- Identify and delineate the freshwater ecosystems affected by the activities;
- Determine the present ecological state, functional importance and conservation value of the freshwater ecosystems that have been affected by the instream dams and road crossings;
- Describe and assess the significance of the potential impacts of the activities on freshwater ecosystems;
- Provide a summary of the findings in the form of a Freshwater Ecology Impact Assessment Report.

2. METHODS

2.1 Desktop Assessment

A desktop assessment was conducted to contextualize the affected watercourses in terms their 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); and
- Western Cape Biodiversity and Spatial Plan (WCBSP) for Oudtshoorn (CapeNature, 2017).

2.2 Baseline Assessment

A site visit was conducted on the 7th of June 2021, with the objective of identifying and classifying watercourses affected by the unlawful activities, determining their Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS), and assessing the impacts of the unlawful activities on the watercourses.

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. Watercourses were categorised into discrete hydrogeomorphic units (HGMs) based on their 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 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 affected watercourses was assessed using methods applicable to the classification of the watercourse (i.e. river or wetland). PES assessments for rivers were conducted using the Index of Habitat Integrity (IHI) (see Appendix 1).

2.2.3 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 of affected watercourses was assessed using methods described in Appendix 2.

2.3 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.
- 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 current conditions.

4. SUMMARY OF ACTIVITIES

4.1.1 Establishment of Boreholes (Portion 19 of 170)

Two new boreholes (KBH02 and KBH03) were established (Figure 1). These boreholes are located within the regulated area of a watercourse (within 100 m of the banks of the Kandelaars River) but are located well outside the riparian zone of the Kandelaars River, within the working agricultural area of the Portion 19 of 170 (Figure 2). KBH02 and KBH03 have been sunk to a depth of 200 and 300 m, respectively.

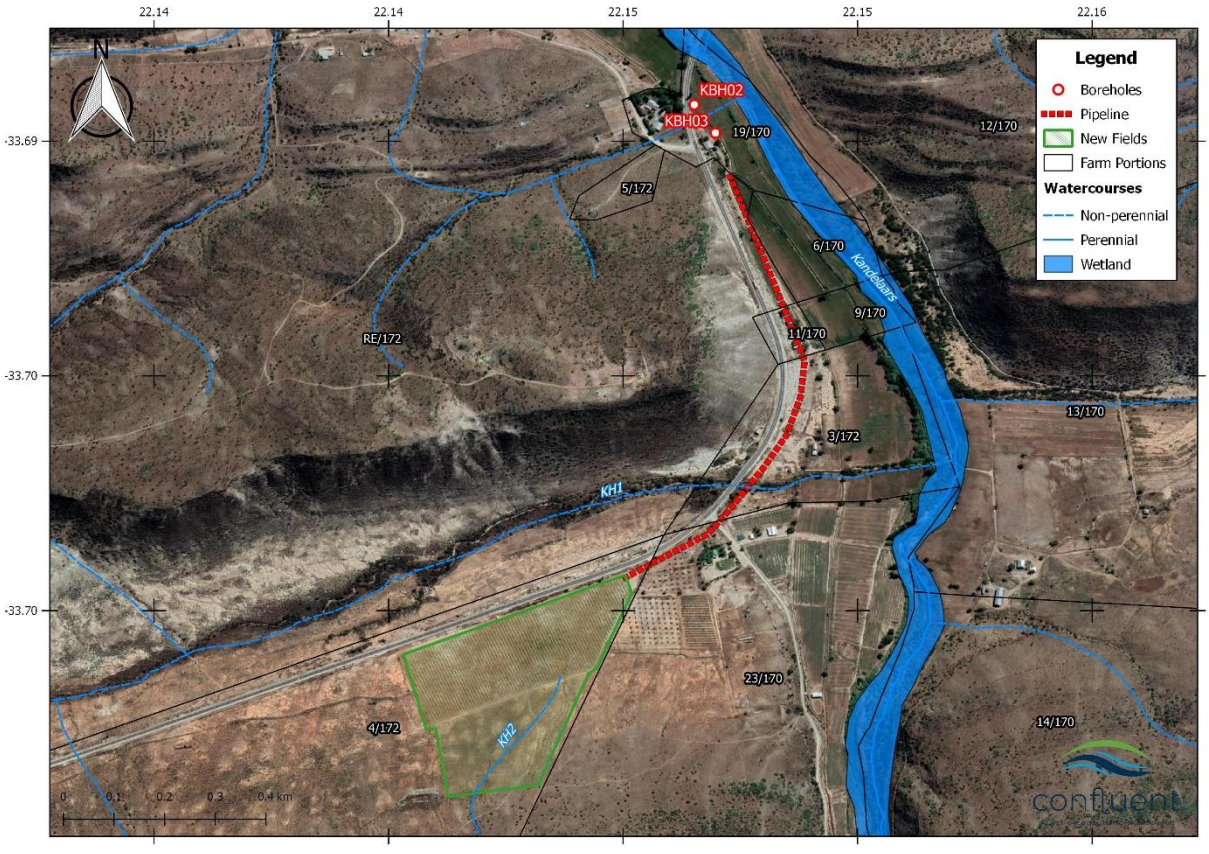

Figure 1: Map indicating unlawful activities in relation to mapped watercourses.

Figure 2: Photograph illustrating the location of KBH02 within an agricultural field and the riparian zone of the Kandelaars River in the background.

4.1.2 Burial of pipeline across a non-perennial river (Portion 3 of 172)

A pipeline transferring water from the boreholes to agricultural fields established on Portion 4 of Farm 172 was constructed (Figure 1). This pipeline crossed a non-perennial river (henceforth referred to as KH1). The pipeline was buried approximately 3m below the riverbed and required a deep trench to be excavated across the watercourse. The alignment of the pipeline fell entirely within the footprint of an existing farm road that crosses the watercourse (Figure 3). Additional disturbance to the banks of the river was therefore minimal apart from a small section on the northern bank where disturbance to riparian habitat was noted. No signs of disturbance caused by the excavation of the riverbed were visible (Figure 4).

Figure 3: Photograph of stream crossing indicating the path of the existing road crossing (beneath which the pipe was laid) and the area of disturbed bank next to the road (red area).

Figure 4: Photograph illustrating uniform riverbed and substrate from just upstream of the pipeline crossing (the pipeline crosses the riverbed along the alignment of an existing road crossing which can be seen along the left bank)

4.1.3 Establishment of Agricultural Fields (Portion 4 of 172)

Agricultural fields were established on Portion 4 of Kellershoogte 172 (Figure 1). The establishment of fields involved ripping the soil. In the process of ripping, a portion of a small non-perennial drainage line draining the hills to south of the field was covered by the newly prepared field (Figure 5). Subsequent rainfall events have resulted in erosion of the fields and re-establishment of a distinct drainage channel through the fields.

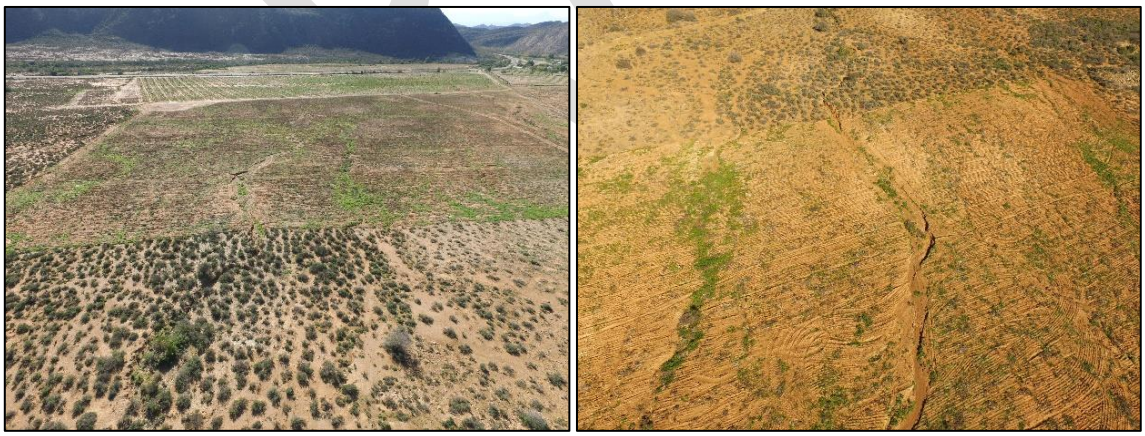

Figure 5: Aerial photographs illustrating the prepared agricultural fields (left) and the re-establishment of a distinct channel through newly established agricultural fields (left and right).

5. STUDY SITE

The properties are located quaternary catchment J35B of the Gouritz Primary Catchment (Figure 6). The catchment area falls within the Southern Folded Mountains ecoregion (Ecoregion Level 2: 25.01) (Figure 7). The terrain morphology consists predominantly of closed hills and mountains of moderate to high relief with altitude ranging from 100 – 1300 m.a.m.s.l. Rainfall is low (MAP of 0 – 400 mm) and occurs predominantly winter but does

occur all year round. Summers are hot (mean daily maximum temperature of 28 to 32 ºC) and winters are mild to cold (mean daily maximum temperature of 12 to 20 ºC).

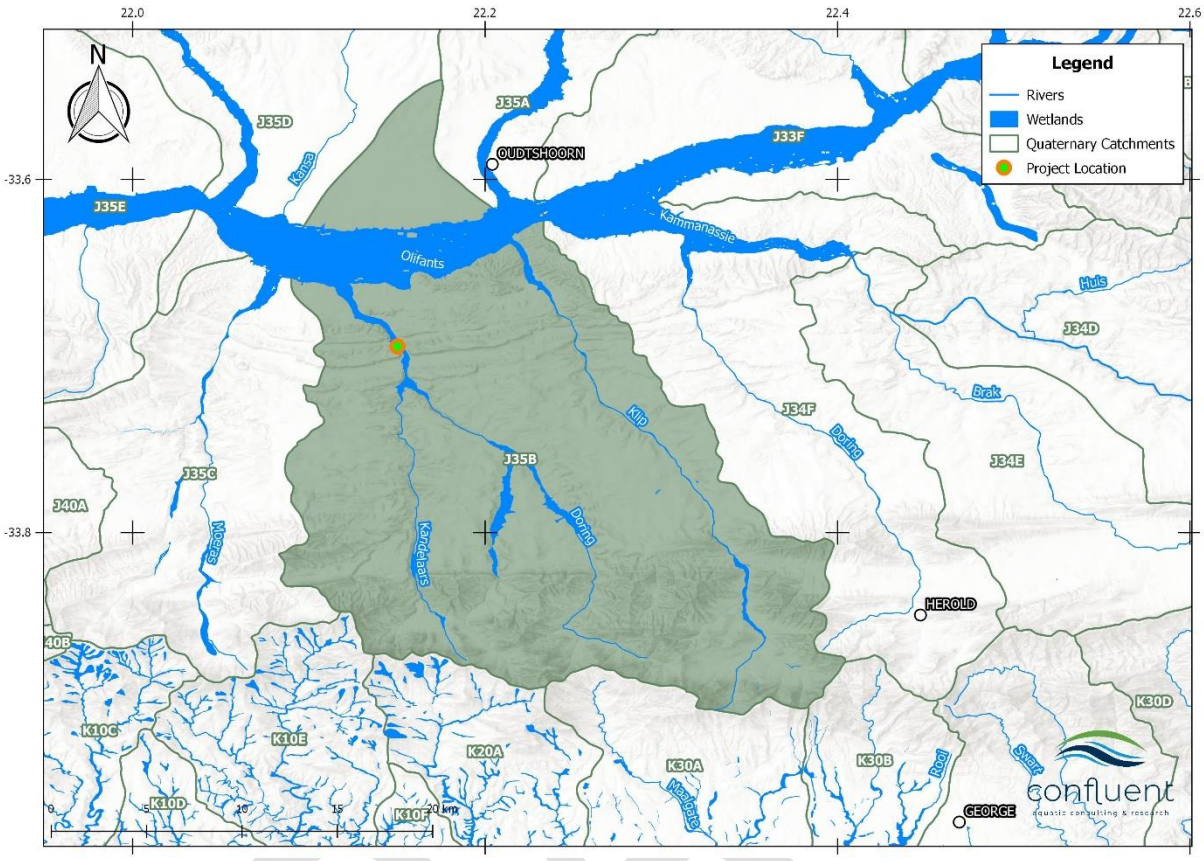

Figure 6: Location of the properties in quaternary catchment J35B.

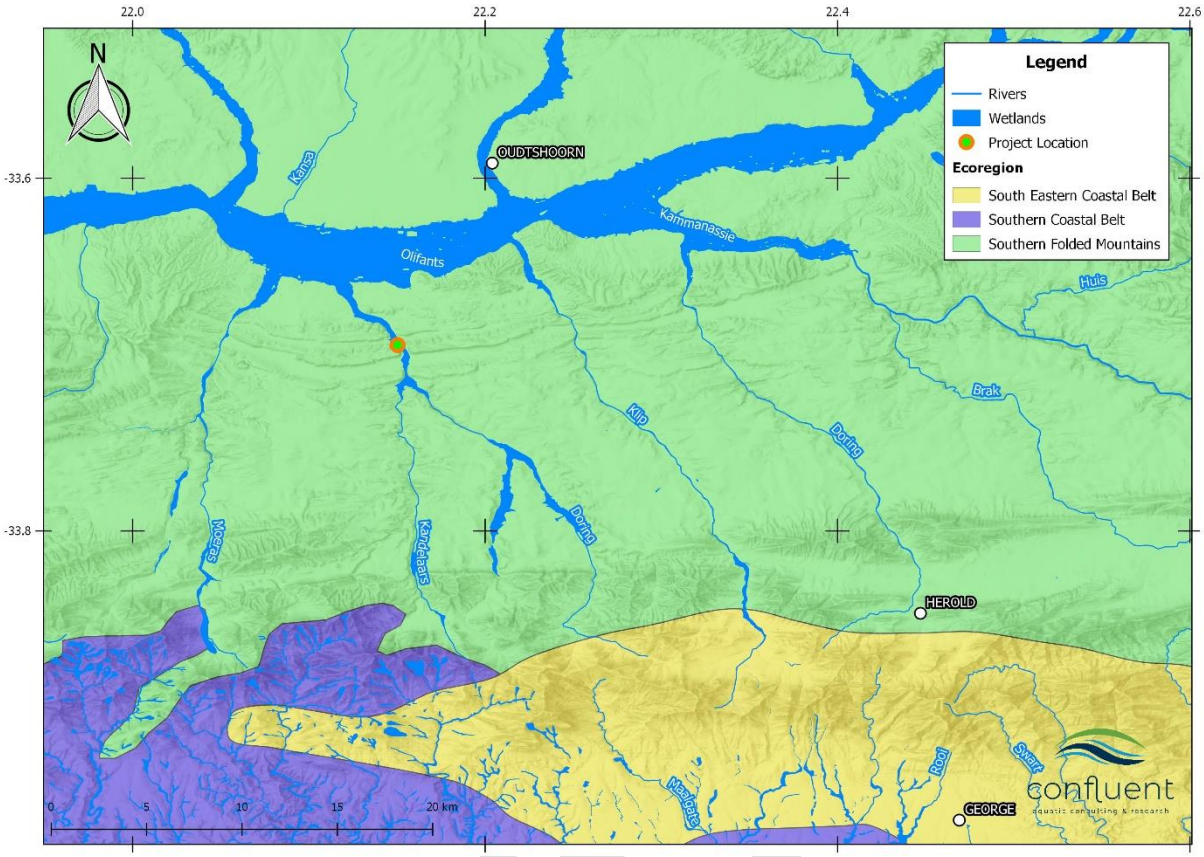

Figure 7: Map indicating the location of the properties in relation to Level 1 Ecoregions.

5.1 National Freshwater Ecosystem Priority Areas (NFEPA)

The properties are located in sub-quaternary catchment (SQC) 8881 (Figure 8). The main river in this SQC is the Kandelaars River, which drains directly into the Olifants River. According to the National Freshwater Ecosystem Priority Atlas, this SQC has been classified as a Fish Support Area (FEPA; Nel *et al.,* 2011). Fish Support Areas are SQCs that are not necessarily in a good ecological condition but are still essential for protecting threatened or near-threatened freshwater fish species that are indigenous to South Africa. The management goal of Fish Support Areas is to prevent additional fish species from becoming threatened or to prevent threatened or near-threatened species from becoming extinct. In order to achieve these objectives, there should be no further deterioration in river condition.

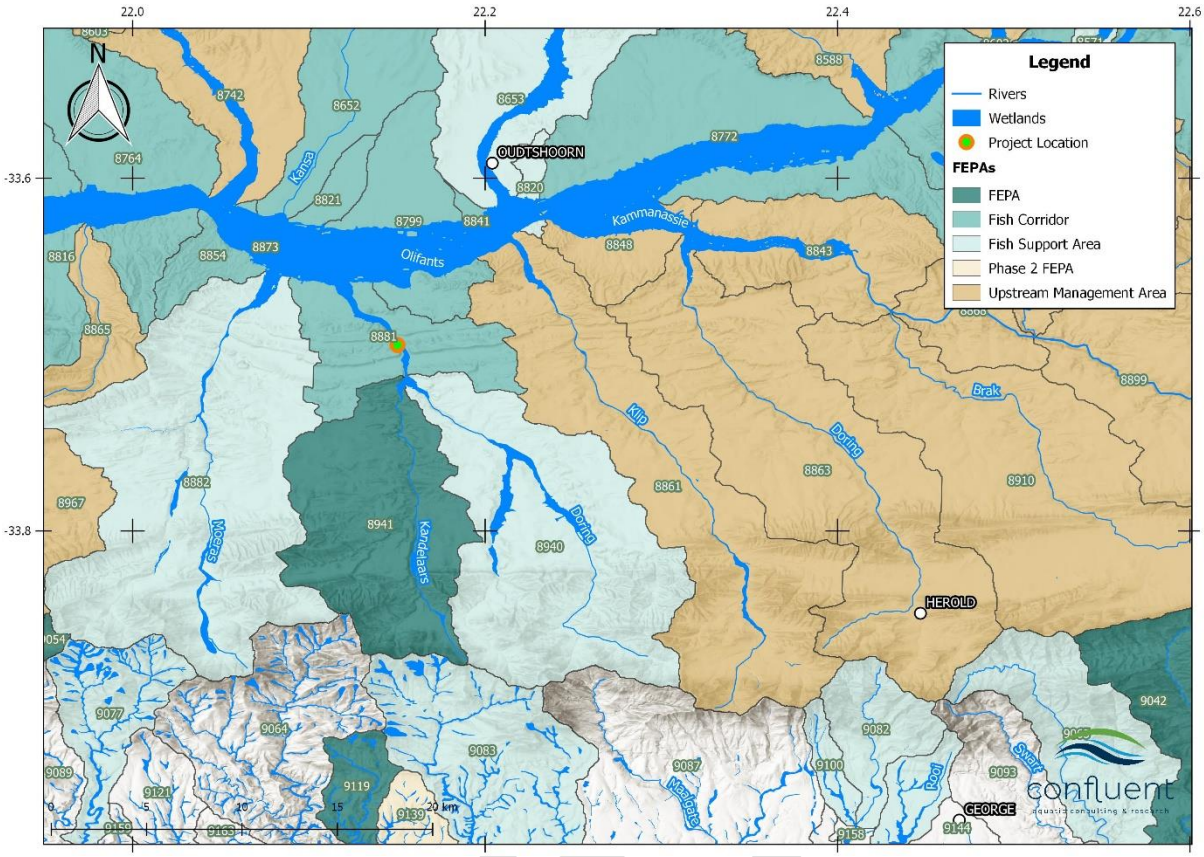

Figure 8: Map of the properties in relation to FEPAs.

5.2 Western Cape Biodiversity Spatial Plan (WCBSP)

According to the WCBSP for Oudtshoorn, the boreholes and the pipeline crossing are located within Ecological Support Areas (ESA2) (Figure 9). The drainage line covered by agricultural fields is an aquatic ESA (ESA1). Management objectives for these conservation planning units are provided in Table 1.

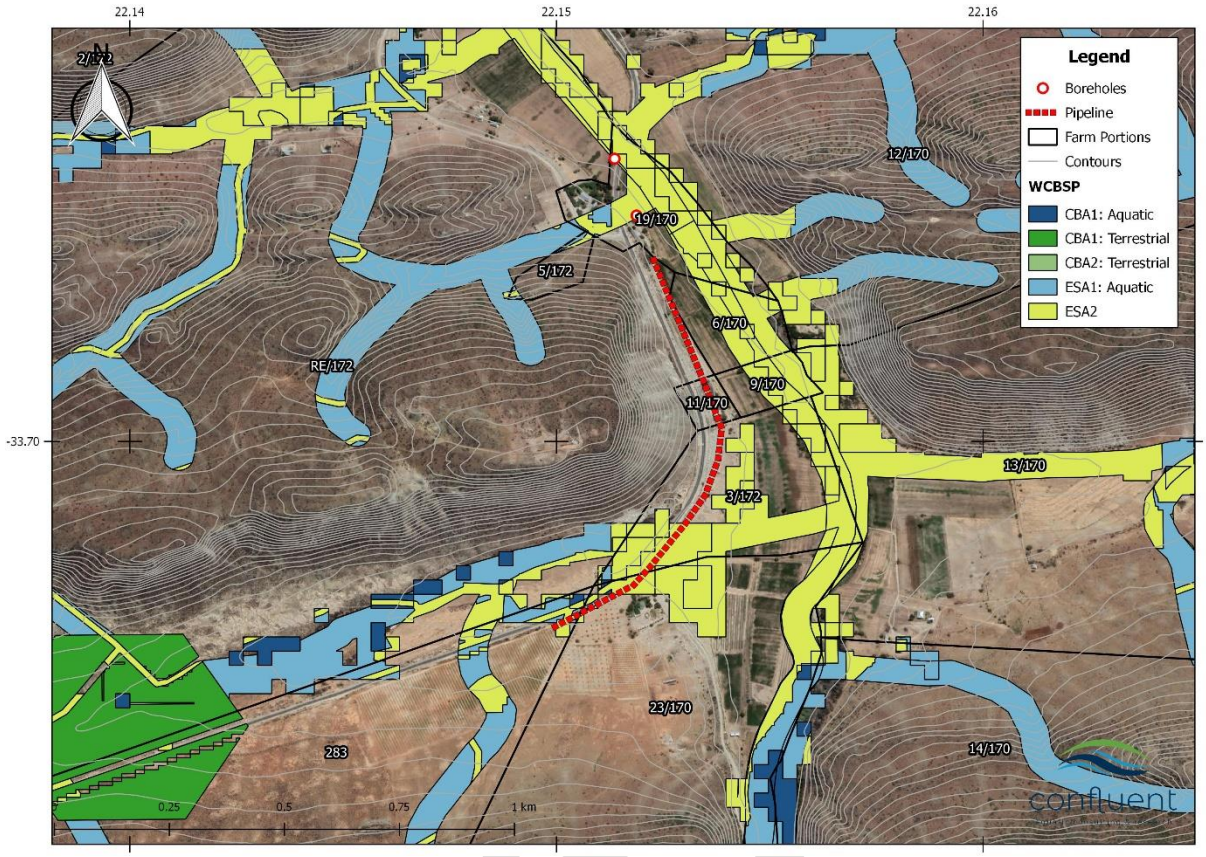

Figure 9: Map of the dams and road crossings in relation to the Western Cape Biodiversity Spatial Plan (WCBSP).

Table 1: Definitions and management objectives of the Western Cape Biodiversity Spatial Plan.

Category	Definition	Management Objective
ESA1	Areas that are not essential for meeting biodiversity targets, but that play an important role in supporting the functioning of PAs or CBAs, and are often vital for delivering ecosystem services.	Maintain in a functional, near-natural state. Some habitat loss is acceptable, provided the underlying biodiversity objectives and ecological functioning are not compromised.
ESA2	Areas that are not essential for meeting biodiversity targets, but that play an important role in supporting the functioning of PAs or CBAs, and are often vital for delivering ecosystem services.	Restore and/or manage to minimize impact on ecological processes and ecological infrastructure functioning, especially soil and water-related services, and to allow for faunal movement.

5.3 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. Portion 19/170, 3/172 and 4/172 fall within quaternary catchment J35B, which falls within the D7 Gouritz-Olifants Integrated Unit of Analysis (IUA). The Water Resource Class for this IUA is III, indicating sustainable minimal protection and high utilisation. Quaternary J35B 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 closest reach of the Olifants River downstream of the study area has been set as an E (Seriously Modified), which indicates a highly impacted river with a low level of protection for high utilisation for socio-economic development.

6. SITE ASSESSMENT

6.1 Watercourse Classification

All watercourses affected by the proposed road alternatives were visited and classified according to Ollis et al. (2013). Several distinct watercourses/hydrogeomorphological units were identified and classified and are indicated in (Figure 10).

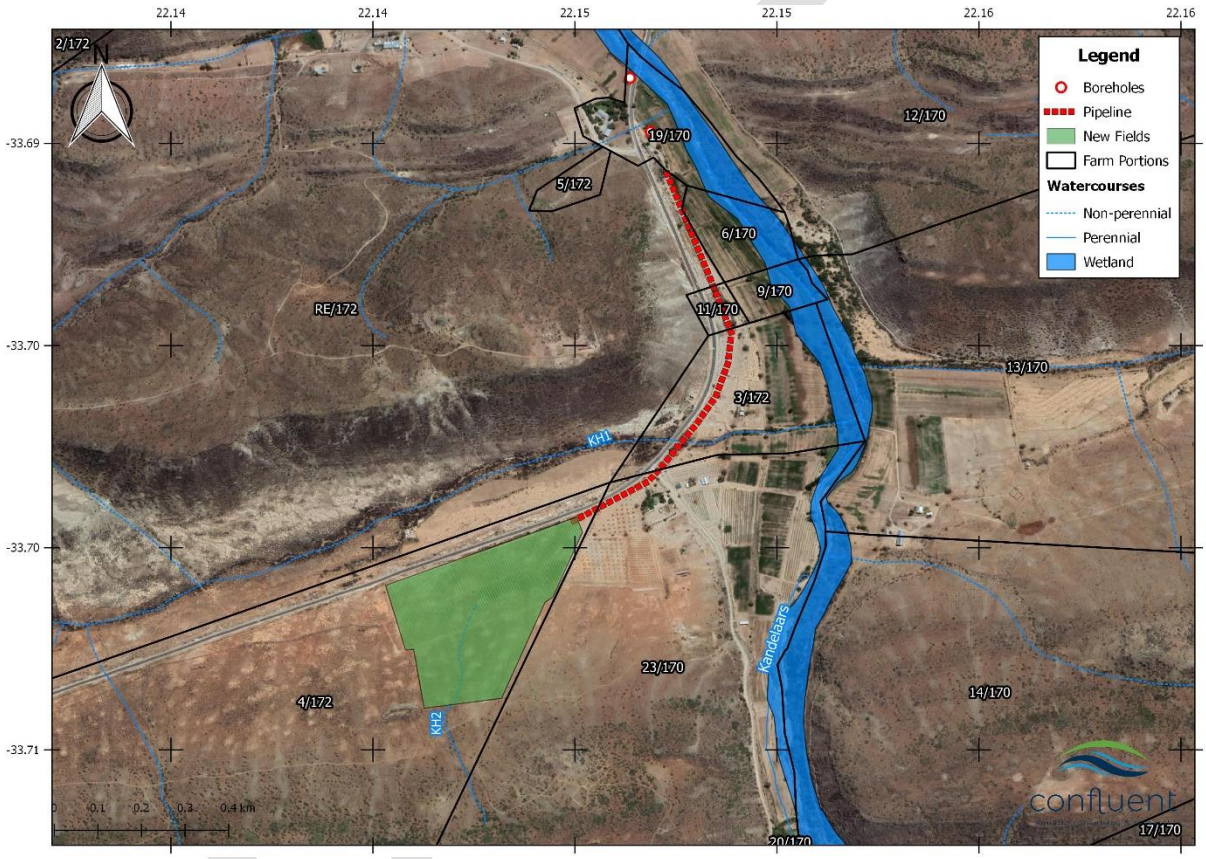

Figure 10: Location of activities in relation to watercourses.

6.1.1 The Kandelaars River

The section of the Kandelaars River running adjacent to Portion 19 of Farm 170 runs through a narrow, flat floodplain area and is classified as a perennial river that falls within an Upper Foothills geomorphological zonation. The floodplain would have historically been seasonally inundated following flood events, sustaining seasonal wetland habitat along the river. Regulation of flow by upstream impoundments has seriously modified the magnitude and timing of floods along the river and the entire floodplain area has been converted to agriculture (agricultural fields were visible in aerial photographs as far back as 1939). There is therefore currently no floodplain wetland habitat associated with the river. For the purposes of this assessment, the Kandelaars River has therefore been assessed as a river. The boreholes are

located within 100 m of the riparian area of the river and therefore do fall within the regulated area of the watercourse.

6.1.2 Unnamed tributary of the Kandelaars River (KH1)

The pipeline crosses a non-perennial river that drains into the Kandelaars River (KH1) (Figure 10). Flow in the river is highly intermittent water and flows for a relatively short time of less than one season's duration (i.e. less than approximately 3 months), at intervals varying from less than a year to several years.

6.1.3 First Order Drainage Line (KH2)

KH2 is a non-perennial drainage line that drains hills located to the south. The drainage line is a very small, narrow watercourse that only receives intermittent, short-term flows (no more than a few days at a time) following rainfall (Figure 11). Given the aridity of the region, the watercourse will therefore seldom flow. The primary ecological function of the watercourse is to deliver periodic surface water flows to downstream water resources (as opposed to sustaining aquatic fauna and flora within the stream reach). This drainage line was historically disconnected from the broader hydrological network and used to terminate (lower down along its length) into a furrow/canal that fed a dam on the property (Figure 12). Following the establishment of the new agricultural fields, the remaining portion of the drainage line now terminates and discharges into the fields, further up along its course. Apart from the modifications to the channel and flow of the watercourse, many sections of the banks of the watercourse did show signs of advanced erosion (Figure 11).

Figure 11: Photographs showing the non-perennial drainage line (KH2) prior to its termination in the newly established agricultural fields (note the eroded banks – right).

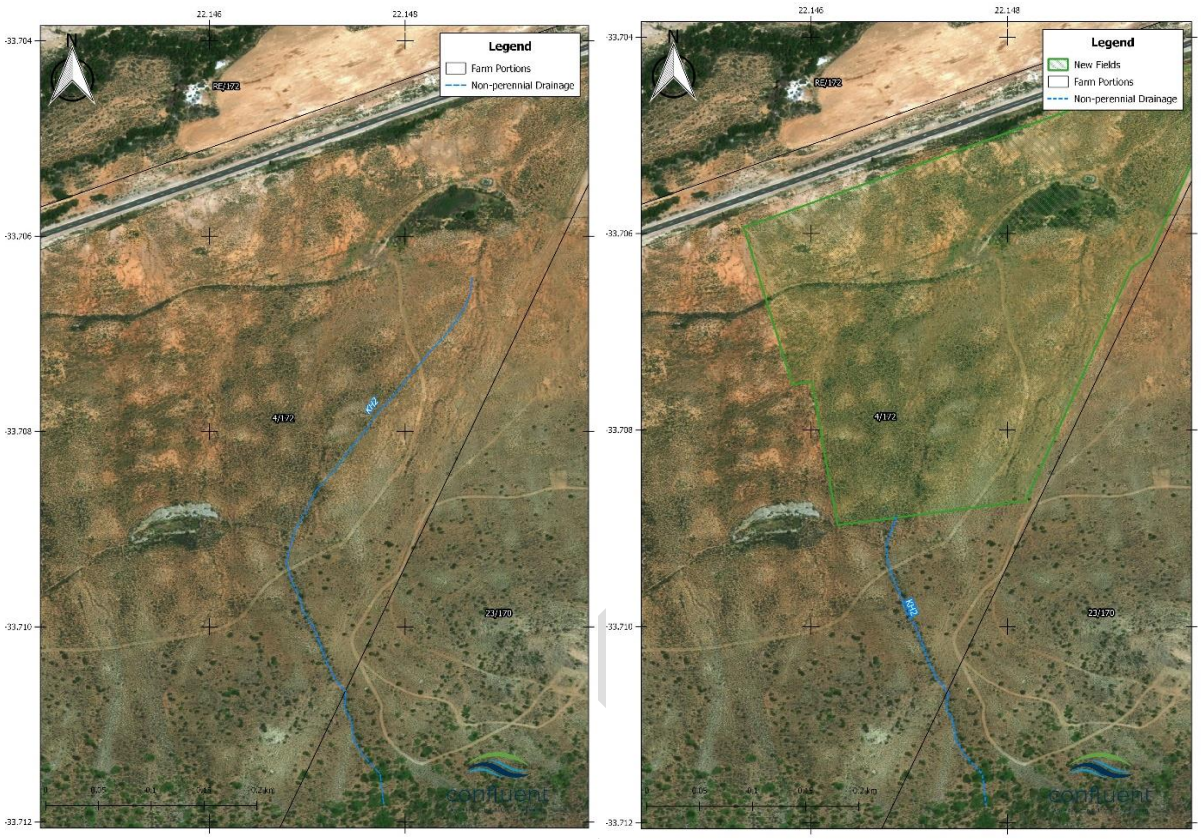

Figure 12: Maps illustrating historical (left – discharging into furrow) and current (right - discharging into newly established fields) fragmentation of the non-perennial KH2 drainage line.

6.2 Present Ecological State (PES)

In order to assist with the interpretation of the impact assessment the PES of each watercourse has been assessed pre and post unlawful activity. This analysis relied on recent historical satellite images taken just prior to the commencement of the unlawful activities.

6.2.1 Kandelaars Floodplain Wetland

The floodplain wetland has been significantly modified over time. Agriculture within the floodplain has occurred as far back as 1939 (year of the first available ortho-photo for the area). The natural area of the wetland has therefore been significantly reduced and the functional wetland habitat has largely been restricted to the river channel and associated riparian zone running through the floodplain. The banks of the river are generally highly disturbed due to the extensive agriculture occurring in the floodplain right up to the riparian zone. Much of the riparian habitat has been removed, and has been replaced with alien invasive vegetation, including *Arundo donax*, *Salix babylonica*, and *Shinus molle*. The other important modification is several instream dams that occur further upstream, which often results in flows in the Kandelaars River drying up. The boreholes are located well outside the riparian zone of the river, within agricultural fields and will not have any effect on the PES of the river which is D (Largely Modified) Table 2.

6.2.2 Unnamed Tributary of Kandelaars River (KH1)

The tributary drains a relatively large catchment area that comprises relatively few actively farmed fields, with land use consisting mainly of natural vegetation utilised for grazing of livestock, game farms etc. A few impoundments do occur further upstream. As the river approaches the Kandelaars River, it passes through the floodplain, where intensive agricultural production encroaches right up to the banks of the river with some associated loss of riparian habitat. Modification to instream habitat has occurred as a result of two main road crossings and several informal, instream low-level crossings. The PES of the river (C – Moderately Modified) is unlikely to have been further modified as a result of the construction of the pipeline (Table 2). A site visit showed no clear indication of the existence of a buried pipeline and rainfall events since the burial of the pipe has resulted in significant sediment transport down the river. The pipeline was buried along the alignment of an existing dirt road that crosses the river so the pipeline did not result in any further degradation to the banks of the river, apart from a small bare section (approximately 9 m^2) where soil had presumably been stockpiled.

6.2.3 Intermittent Drainage Line (KH2)

As described previously, the drainage line was previously disconnected from the broader hydrological network by a historical furrow system. In addition, many sections of the existing channel were eroded into relatively incised gulleys. Based on this channel modification the PES of the drainage line was D (Largely Modified). Establishment of the agricultural fields has resulted in further loss of instream and riparian habitat, and while there was a deterioration in the score, the PES remains D (Largely Modified).

Table 2: Instream and Riparian IHI scores for the Kandelaars River and KH1 and KH2.

Modification	Kandelaars		KH1		KH2	
	Pre	Post	Pre	Post	Pre	Post
Water abstraction	**18 –** High rates of abstraction	**18**	**5 –** Non-perennial – limited abstraction	**5**	**9 –** Highly intermittent, but all flows abstracted into a furrow system.	**9**
Flow modification	**20 –** Low flows and small to moderate floods impeded by instream dams	**20**	**6 –** Few dams in the catchment	**6**	**15 –** All flows diverted out of channel into a furrow system. Impact moderate due to highly intermittent flow regime	**15**
Bed modification	**11 –** Increased sediment inputs from the catchment area due to agriculture	**11**	**11 –** Increased sediment inputs from the catchment area due to agriculture	**11**	**11 –** Increased sediment inputs from the catchment area due to agriculture	**11**
Channel modification	**11 –** Eroded channel due to alien invasive species and encroachment of agricultural fields.	**11**	**10 –** Several formal and informal road crossings and encroachment by agricultural fields	**10**	**16** – Lower section of channel hydrologically disconnected from broader hydrological network.	**21**
Physico-chemical modification	**5 –** Minor inputs from agriculture	**5**	**5 –** Minor inputs from agriculture	**5**	**2 –** Minor inputs from agriculture	**2**
Inundation	**7 –** Several localities inundated by instream dams	**7**	**5 –** Limited inundation by dams and road crossings	**5**	**0 –** No inundation	**0**
Alien macrophytes	**0** – None	**0**	**0 -** None	**0**	**0 -** None	**0**
Alien aquatic fauna	**0** - None	**0**	**0 -** None	**0**	**0 -** None	**0**
Rubbish dumping	**5 –** Minor	**5**	**5 –** Minor	**5**	**0 –** None	**0**
Instream IHI score	46 (D – Largely Modified)	46 (D)	71 (C – Moderately Modified)	71 (C)	54 (D – Largely Modified)	50 (D)
Vegetation removal	**17** – High rates of riparian vegetation removal	**17**	**10** – Some minor vegetation removal to accommodate agricultural fields and road crossings	**10**	**8** – Some minor vegetation removal to accommodate pastures	**15**
Invasive vegetation	**17** – Invasion by *Arundo donax, Salix babylonica,* and *Shinus molle*	**17**	**3** – Minor	**3**	**3** – Minor	**3**

Modification	Kandelaars		KH1		KH2	
	Pre	Post	Pre	Post	Pre	Post
Bank erosion	**15 –** Significant erosion along sections of the river	**10**	**7 –** Increased erosion due to clearing of AIPs	**7**	**14 –** Significant erosion of banks	**14**
Channel modification	**11 –** Eroded channel due to alien invasive species.	**11**.	**10** –	**10**	**16** – Lower reach disconnected from river reach	**21**
Water abstraction	**5** – Minimally affected by abstraction.	**5**	**2** – Minimally affected by abstraction.	**2**	**2** – None.	**2**
Inundation	**7 –** Inundation by dams upstream	**7**	**0** – None	**0**	**0** - None	**0**
Flow modification	**5** – Minimally affected by flow modifications	**5**	**3** – Minor	**3**	**3** – Minor	**3**
Physico-chemical modification	**0 –** None	**0**	**0** - None	**0**	**0 -** None	**0**
Riparian IHI Score	35 (E – Seriously Modified)	35	84 (B – Largely Natural)	84 (B)	55 (D – Largely Modified)	49 (D)
Combined Score	**41 (D – Largely Modified)**	**41 (D)**	**78 (C – Moderately)**	**78 (C)**	**55 (Largely Modified)**	**49 (D)**

6.3 Ecological Importance & Sensitivity

Certain attributes of the Kandelaars River are ecologically important, specifically with respect to its designation as a national Fish Support Area and the presence of the endangered redfin species (*Pseudobarbus tenuis).* It is therefore important as a migration route within the larger hydrological network. The EIS is therefore **High** (Table 3). Given the non-perennial and highly intermittent flow characteristics of the of KH1 and KH2, these watercourses are not important with respect to hosting a diverse aquatic assemblage. The main function of these watercourses is to supply flows to downstream areas as opposed to hosting instream aquatic fauna and flora. Similarly, the intermittent flows and geomorphological characteristics limits the diversity of aquatic habitat features and refuge and migration options for aquatic biota. The EIS of these watercourses is therefore **Low** (Table 3)**.**

Table 3: Ecological Importance and Sensitivity scores for the Kandelaars River and KH1 and KH2.

Determinant	Kandelaars	Tributary	Drainage
Presence of Rare & Endangered Species	**4** – *Pseudobarbus tenuis*.	**0** – No rare or endangered taxa.	**0** – No rare or endangered taxa.
Populations of Unique Species	**1** – One population judged to be unique at a local scale.	**0 –** No unique species.	**0 –** No unique species.
Intolerant Biota	**2** - Moderate proportion of the biota is expected to be dependent on permanently flowing water during all phases of their life cycle.	**1** - Very low proportion of biota is expected to be dependent on flowing water for the completion of their life cycle.	**1** - Very low proportion of biota is expected to be dependent on flowing water for the completion of their life cycle.
Species/Taxon Richness	**1** – Relatively low species richness (DWS, 2011)	**1** - Low diversity of fauna and flora expected on a local scale.	**1** - Low diversity of fauna and flora expected on a local scale.
Diversity of Habitat Types or Features	**2** – Important at a local scale.	**1** – Non-perennial, with little geomorphological variation	**1** – Non-perennial, with little geomorphological variation.
Refuge value of habitat types	**2** – Important at a local scale.	**1** – Small non-perennial river which will offer limited refuge following flooding events.	**1** – Small non-perennial river which will offer limited refuge following flooding events.
Sensitivity of habitat to flow changes	**2** – Moderately sized river, sensitive to flow decreases during certain seasons.	**1** – A non-perennial river which is unlikely to be sensitive to changes in flow.	**1** – A non-perennial river which is unlikely to be sensitive to changes in flow.
Sensitivity to flow related water quality changes	**2** – Moderately sized river, sensitive to flow decreases during certain seasons.	**1** – A non-perennial river sensitive to modifications in water quality.	**1** – A non-perennial river sensitive to modifications in water quality.
Migration route for instream and riparian biota	**3**– The stream delineation is an important link in terms of connectivity for the survival of biota upstream and downstream and is sensitive to modification	**1 -** The stream delineation is of low importance in terms of connectivity for the survival of biota upstream and downstream.	**0 -** The stream delineation is not of any importance in terms of connectivity for the survival of biota upstream and downstream.
Protection Status	**3** – Fish Support Area - The stream delineation is in an area important for the conservation of ecological diversity on a national scale.	**1** – ESA	**1** – ESA
EIS Score	**Moderate (2.2)**	**Low (0.8)**	**Low (0.7)**

6.4 Site Sensitivity

Future expansion of agricultural fields on Portion 4 of 172 Kellershoogte must take existing aquatic features to the west of the property into account (Figure 13). These watercourses are similar to KH2 but are still largely connected to the broader hydrological network. Given that

these watercourses are narrow first order streams, with limited aquatic biodiversity value, a 5 m buffer is considered adequate for their protection. Future preparation of agricultural fields must therefore not disturb these watercourses and recommended 5 m buffers must be implemented. No fields or infrastructure must be located within these 5 m buffers.

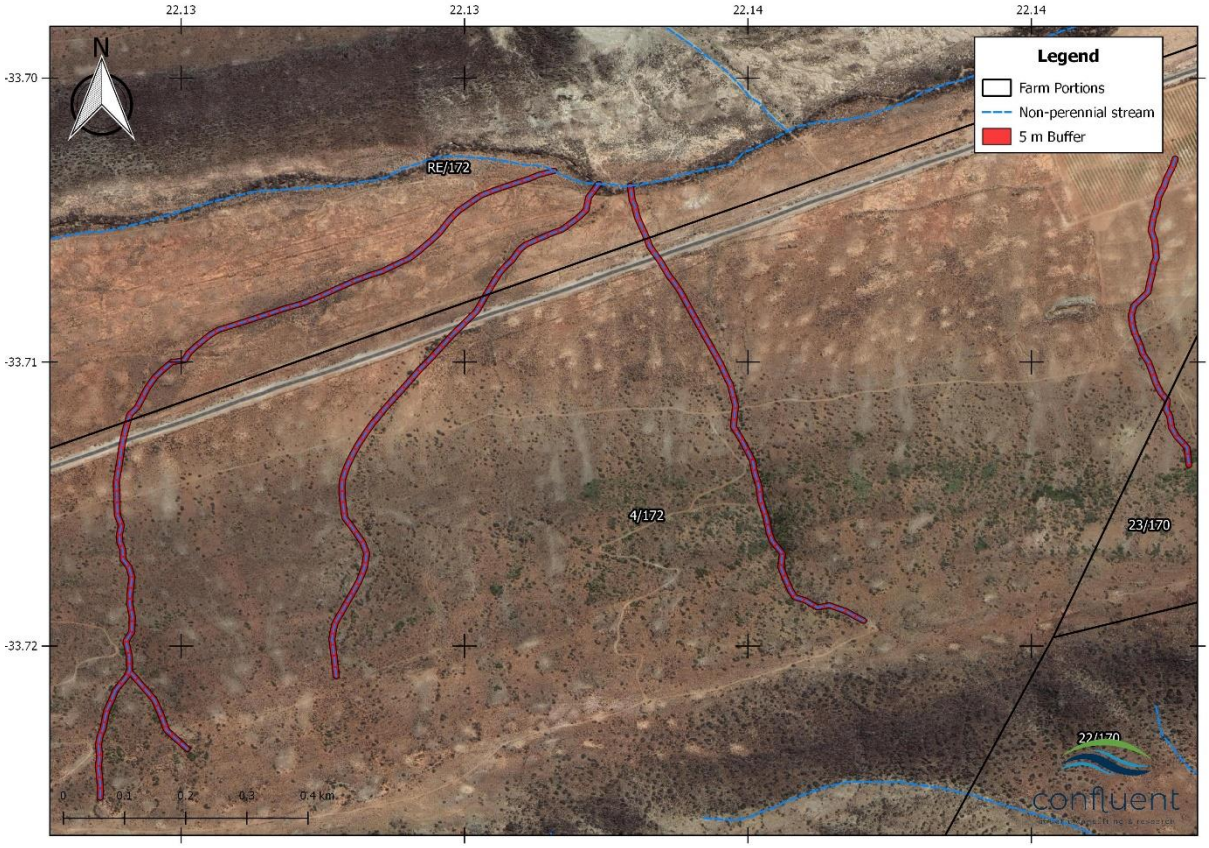

Figure 13: Map indicating aquatic features (and the recommended 5 m buffer) on Portion 4 of Kellershoogte 172.

7. IMPACT ASSESSMENT

Two alternatives were assessed. Alternative 1 is for 70 ha of orchards, covering existing small non-perennial drainage lines that drain from the south (Figure 14). Alternative 2 (the preferred alternative) is for 56 ha of orchards and buffers each drainage line by 5 m (as per Figure 13) and also allows for the re-establishment of KH2 (which was covered by the establishment of the initial orchard area) (Figure 15).

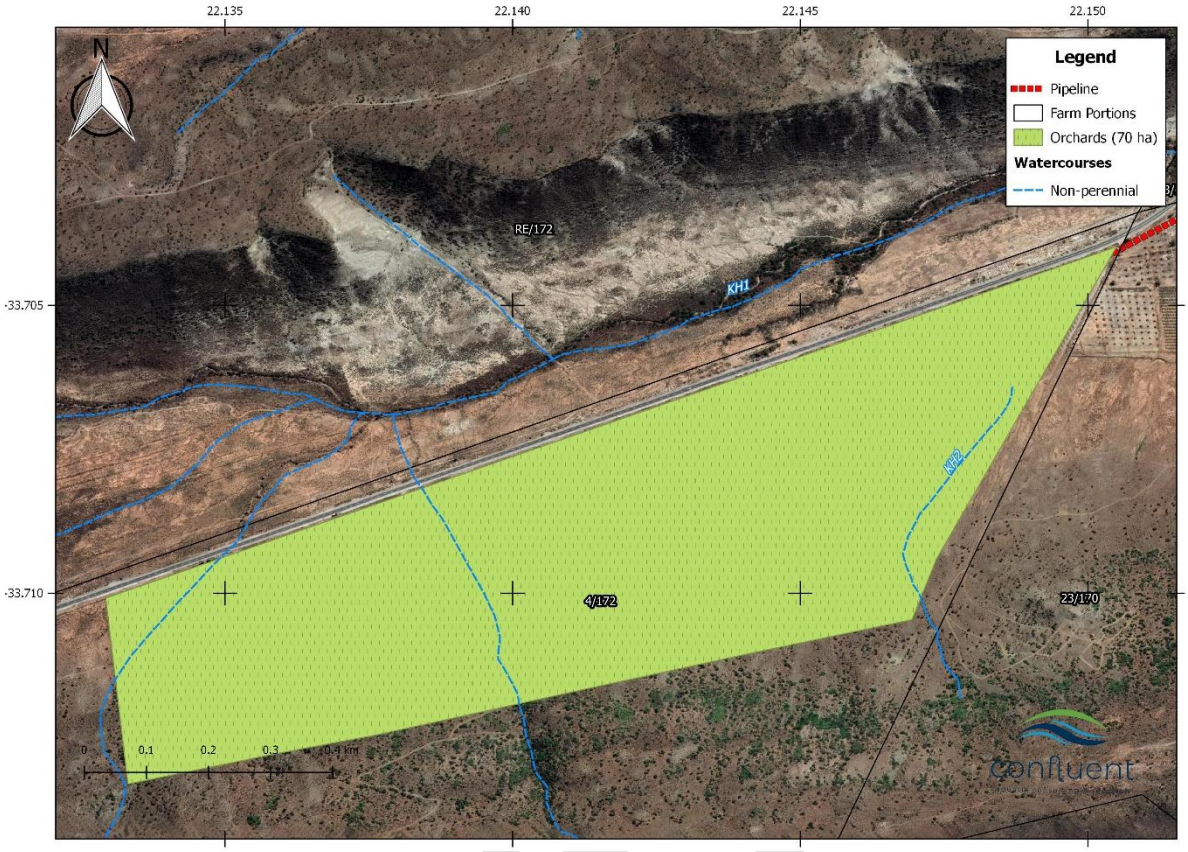

Figure 14: Map indicating the layout for Alternative 1

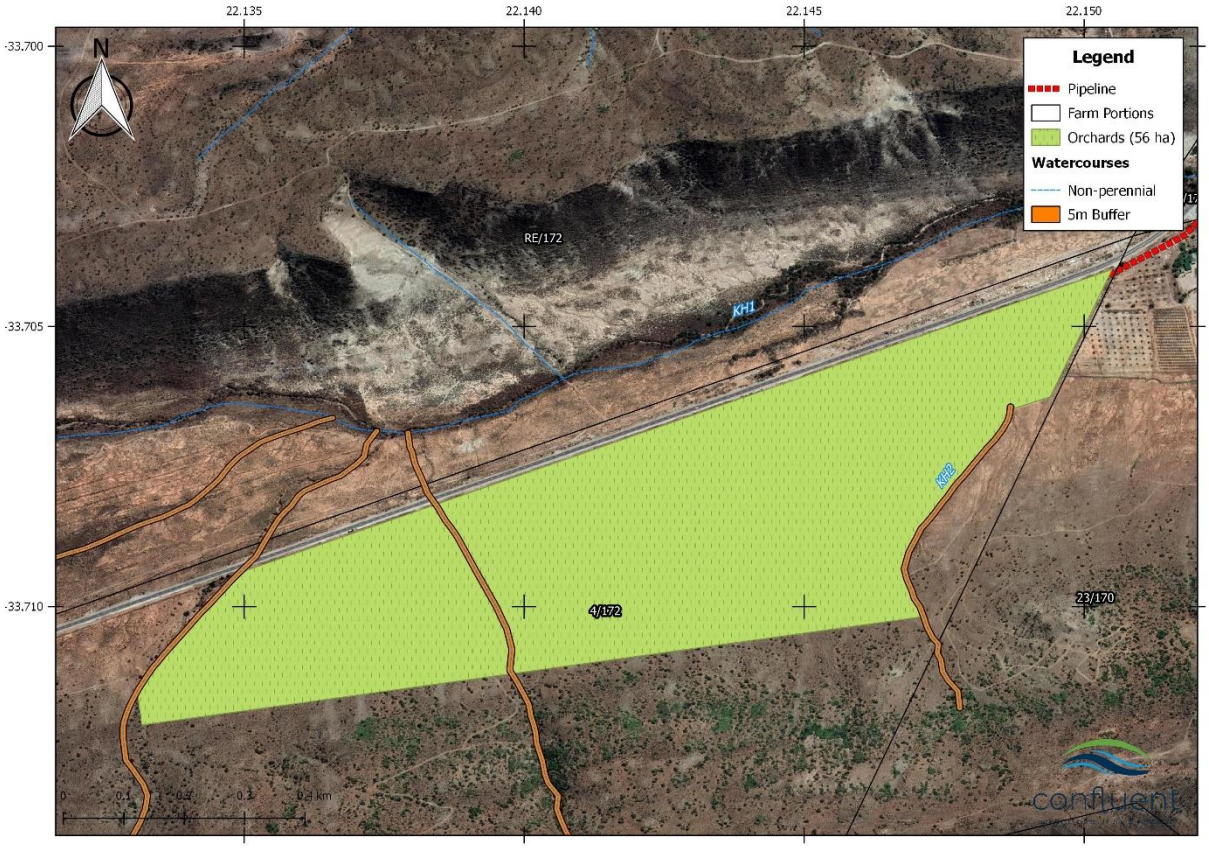

Figure 15: Map indicating the layout for Alternative 2 (preferred alternative).

7.1 Construction Phase Impacts

Each of the impacts expected to have occurred during the construction phase have been assessed in terms of their significance. As the impact assessment is retrospective by nature, it is unknown, but unlikely that any rigorous mitigation measures were implemented during the construction phase to prevent environmental degradation.

Impact 1: Disturbance of river and riparian habitat (Kandelaars River) during the construction of the boreholes

While the boreholes are located within the regulated area of the watercourse (i.e. within 100 m of the banks of the river), they have been sunk well outside of the existing riparian zone of the river, well within the working agricultural area of the farm (i.e. outside of the outer edge of agricultural fields located immediately adjacent to the river). It is therefore highly unlikely that the establishment of the boreholes resulted in any degradation to aquatic and riparian habitat as construction vehicles had no need to enter the delineated area of the watercourse.

	Without Mitigation
Intensity	Negligible
Duration	Brief
Extent	Very limited
Probability	Highly unlikely
Significance	**-4: Negligible (-)**
Reversibility	High
Irreplaceability	Low
Confidence	High

Impact 2: Disturbance of river and riparian habitat as a result of the excavation of the trench to lay the pipeline across KH1.

Laying the pipeline would have required that the bed and banks of the KH1 non-perennial stream were excavated along the section where the pipe crosses the river. The pipeline did however follow the alignment of an existing farm road that crosses KH1 at this point. In this respect, disturbance to the bed and banks was minimised as the pipeline fell entirely within the existing footprint of the road. Some minor disturbance to riparian vegetation did occur on the northern bank, presumably as a result of temporarily stock piling of soil from the trench (which was then scraped back into the trench).

	Without Mitigation	With Mitigation
Intensity	Very Low	Negligible
Duration	Short Term	Short Term
Extent	Very limited	Very limited
Probability	Certain	Certain
Significance	**-42: Minor (-)**	**-35: Negligible (-)**
Reversibility	High	High
Irreplaceability	Low	Low
Confidence	High	High

Mitigation:

- The small disturbed riparian area on the northern bank must be revegetated with plant species typical of the surrounding area.

Impact 3: Sedimentation of river habitat during the excavation of the trench crossing the KH1.

Exposed trench could potentially have resulted in temporary increased availability of mobile sediment that could be mobilised during rainfall events. The probability of rain having occurred during this period was however very low, given the aridity of the environment and the current drought conditions.

	Without Mitigation
Intensity	Low
Duration	Short term
Extent	Limited
Probability	Unlikely
Significance	**-24: Negligible (-)**
Reversibility	High
Irreplaceability	Low
Confidence	High

Impact 4: Loss of aquatic biodiversity due to loss of instream and riparian habitat caused by establishing agricultural fields across KH2.

Establishment of agricultural fields covered the non-perennial drainage line (KH2). This resulted in the loss of associated habitat. Loss of this habitat did not however result in a significant alteration to the ecological function of the watercourse as it had already been disconnected from the broader hydrological network prior to the establishment of the agricultural fields. From an aquatic biodiversity perspective, the watercourse is highly intermittent and does not host a diverse array of aquatic fauna and flora. The intensity of the impact is therefore not considered to be very high based on the condition of the watercourse prior to the activity. Alternative 1 cannot be mitigated.

	Alternative 1	Alternative 2	
	Without Mitigation	**Without Mitigation**	**With Mitigation**
Intensity	Low	Low	Very low
Duration	Permanent	Permanent	Medium Term
Extent	Very limited	Very limited	Very limited
Probability	Certain	Certain	Certain
Significance	**-77: Moderate (-)**	**-77: Moderate (-)**	**-49: Minor (-)**
Reversibility	High	High	High
Irreplaceability	Low	Low	Low
Confidence	High	High	High

Mitigation:

- Runoff from the undisturbed section of the river reach is discharging into the prepared fields and creating a new channel. This channel should be allowed to re-establish through these fields (which are currently not planted) until water infiltrates into the soil. A 5 m buffer should be established along this channel to allow water to flow freely (and avoid further erosion to fields and damage to crops)
- Indigenous vegetation should be allowed to re-establish within the 5 m buffer and control of alien invasive plant species must take place to ensure that these do not establish.
- Further expansion of agricultural fields must avoid modifying additional non-perennial watercourses located to the west of KH2. 5 m buffers must be established around these watercourses;
- No fields or infrastructure must be located within the 5 m buffer for these watercourses.

7.2 Operational Phase Impacts

Impact 5: Drawdown of the alluvial aquifer and associated base flows caused by abstraction of water from the boreholes.

Water will be abstracted from a very deep aquifer which is disconnected from the alluvial aquifer. Abstraction from these depths is not expected to impact on sub-surface flows in the alluvial aquifer and will therefore have no additional effect on base flows in the river.

	Without Mitigation	With Mitigation
Intensity	Negligible	Negligible
Duration	Brief	Brief
Extent	Local	Limited
Probability	Highly unlikely	Highly unlikely
Significance	**-6: Negligible (-)**	**-6: Negligible (-)**
Reversibility	High	High
Irreplaceability	Low	Low
Confidence	High	High

Mitigation:

- No mitigation required (see geohydrological report)

Impact 6: Impedance of flow caused by infilling of the trench crossing the unnamed non-perennial tributary (KH1) of the Kandelaars River.

The river bed and river substrate has re-established over the area where the trench was excavated. There is no visible difference in the characteristics of the bed upstream and downstream of the pipeline crossing. Impedance of flow is therefore highly unlikely.

	Without Mitigation	With Mitigation
Intensity	Very low	Negligible
Duration	Brief	Brief
Extent	Limited	Limited
Probability	Unlikely	Highly unlikely
Significance	**-18: Negligible (-)**	**-5: Negligible (-)**
Reversibility	High	Medium
Irreplaceability	Low	Low
Confidence	High	High

Mitigation:

- While the pipeline has been buried deep beneath the river-bed, the crossing must be routinely inspected to ensure that flows following high rainfall events have not scoured potentially loosely compacted soil from the infilled trench causing the formation of a nick-point, which could potentially result in further erosion of the river bed; and
- The formation of nick-points or localised areas of scour must be immediately filled (using material from the riverbed) or re-profiled and compacted to ensure a continuous slope along the river reach.

Impact 7: Impedance of flow caused by establishing agricultural fields across the non-perennial watercourse (KH2).

Impacts are assessed based on the condition of the watercourse prior to establishment of the fields. The watercourse was previously disconnected from the broader hydrological network as it terminated into a furrow system which fed a dam on the property. The added impact of ploughing through a portion of the watercourse does not result in a significant added impact and the watercourse is still unable to transfer flows into the broader hydrological network. Any water delivered via the watercourse will infiltrate into the soil. Alternative 1 cannot be mitigated. There is no difference in impact between the mitigated an unmitigated option for Alternative 2. This is because the effect of the fields on the impedance of flow is the same as the furrow that used to be present prior to the establishment of the fields.

	Alternative 1	Alternative 2	
	Without Mitigation	**Without Mitigation**	**Without Mitigation**
Intensity	Very low	Very low	Very low
Duration	Permanent	Permanent	Permanent
Extent	Very limited	Very limited	Very limited
Probability	Certain	Certain	Certain
Significance	**-70: Minor (-)**	**-70: Minor (-)**	**-70: Minor (-)**
Reversibility	High	High	High
Irreplaceability	Low	Low	Low
Confidence	High	High	High

Mitigation:

- Runoff from the undisturbed section of the drainage line is discharging into the prepared fields and creating a new channel. This channel should be allowed to re-establish through these fields (which are currently not planted) until water infiltrates into the soil. A 5 m buffer should be established along this channel to allow water to flow freely (and avoid further erosion to fields and damage to crops)
- Indigenous vegetation should be allowed to re-establish within the 5 m buffer and control of alien invasive plant species must take place to ensure that these do not establish.
- Further expansion of agricultural fields must avoid modifying additional non-perennial watercourses located to the west of KH2. 5 m buffers must be established around these watercourses;
- No fields or infrastructure must be located within the 5 m buffer for these watercourses.

7.3 Alignment to Management Objectives

In general, all activities and associated impacts are aligned to provincial and national conservation and water resource management objectives (Table 4). The exception is ploughing agricultural fields through KH2. It is important to stress however that the functional state of the watercourse had already been compromised prior to the establishment of fields. The functional state of the watercourse has therefore not changed since prior to the establishment of the agricultural fields but some habitat loss has occurred.

Table 4: Compliance of activities to national and provincial conservation plans and water resource management objectives.

	Management Objective	Description
NFEPA	Fish Support Area- Prevent additional fish species from becoming threatened or to prevent threatened or near-threatened species from becoming extinct. No further deterioration in river condition.	Kandelaars River unaffected by activities
WCBSP	KH1 - Restore and/or manage to minimize impact on ecological processes and ecological infrastructure functioning, especially soil and water-related services, and to allow for faunal movement	Impacts as a result of pipeline crossing are negligible and riverbed restored to condition prior to activity. Minor rehabilitation of northern river-bank required.
	KH2 - Maintain in a functional, near-natural state. Some habitat loss is acceptable, provided the underlying biodiversity objectives and ecological functioning are not compromised.	Additional habitat loss has occurred. The drainage line had previously discharged into a furrow that fed a dam. Given the highly intermittent nature of these streams, the main ecological function is the delivery of surface water flows to the broader hydrological network (as opposed to for example supporting instream aquatic biodiversity within the stream reach). In this respect the drainage line had already been fragmented by the furrow diversion and its main ecological function had therefore already been lost prior to additional habitat loss caused by the establishment of the fields.
RQOs	Kandelaars River - TEC of a category E	Kandelaars River unaffected by activities and no risk posed to the TEC.

8. CONCLUSION

Construction and operation of the boreholes and pipeline adjacent to and across the Kandelaars River, and KH1 (unnamed tributary of the Kandelaars River) had/will have negligible impacts on these watercourses and are acceptable from a freshwater biodiversity perspective. Furthermore, these specific activities do not compromise the conservation and water resource management objectives that have been set for these watercourses.

The preparation of agricultural fields across KH2 has resulted in the loss of aquatic habitat. It is however important to assess this impact in relation to the ecological function of the watercourse and its historical condition prior to the establishment of the agricultural fields. The watercourse is a highly intermittent first order drainage line and its primary function is to deliver periodic surface runoff flows to downstream water resources. The drainage line does not support aquatic fauna or flora along its reach as flows are too intermittent and too brief to allow for the establishment of such. Historically, this stream had been disconnected from the broader hydrological network as it terminated into a furrow system that fed a small dam on the property. The establishment of fields across the drainage line has therefore not resulted in any further loss of ecological function as the drainage is still disconnected. In summary, while loss of habitat has occurred along KH2, the ecological function remains unchanged and impacts are therefore relatively low. The preferred alternative will result in the re-establishment of this channel in the short to medium term. Care should be taken to ensure that similar watercourses located to the west of KH2 are not similarly disturbed. Some of these watercourses are

connected to the broader hydrological network and ecological function will therefore be lost if these were to be ploughed.

Overall, the activities that have occurred are acceptable from a freshwater biodiversity perspective and it is recommended that Alternative 2 (the preferred alternative) should be authorised.

9. REFERENCES

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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 5) 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 5);
- 25 = maximum possible score for a criterion; and
- Weight = Weighting score for the criteria (Table 6).

Table 5: 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 6: 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 7).

Table 7: 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

Reference:

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.

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 8.

Table 8: 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:

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

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 9.

Table 9: 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 10.

Table 10: 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 11).

Table 11: 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