Aquatic Specialist Impact Assessment for the Section 24G and Water Use License Applications required for Portions 4 and 9 / 232 Redford Farm, Knysna

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• I do not have any influence over decisions made by the governing authorities;

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1. INTRODUCTION

1.1 Background

Confluent Environmental (Pty) Ltd were appointed by the owner of portions 4 & 9 / 232 Redford Farm to conduct an aquatic impact assessment for a Section 24g and Water Use License Application (WULA). The landowner purchased Portion 9 in 2017 and Portion 4 in 2020. More recently, the farm was expanded through purchase of a section of Portion 1 / 232 which was sub-divided and consolidated with Portion 4. The collective farm portions are known as Redhaus Farm.

Agricultural fields have been planted with Almond orchards or cover crops. Two watercourses traverse Redhaus Farm and each watercourse has been dammed at two locations.

Portion 1: One instream dam (Dam 3) was constructed by the previous owner of the property without environmental authorisations between 2006 and 2009 (Figure 1). The current landowner recently (2021) cleared sediment and littoral vegetation from the dam to maintain its capacity.

Figure 1. Dam 3 constructed on Portion 1 pictured in 2009 on Google satellite imagery.

Portion 4: Two instream dams were constructed pre-1998 (Dam 2 and Dam 4). The current landowner recently cleared out both dams to remove sediment and littoral vegetation. Both dams were enlarged from their previous capacity during this process, which occurred during 2020 and 2021.

Figure 2. Two dams on Portion 4 present in 2016 (above) and enlarged in 2021 (below). The left dam is referred to as Dam 4 and the right dam is Dam 2.

Portion 9: One instream dam (Dam 1) was constructed between 2000 and 2004 by the previous landowner with no environmental authorisation. The current landowner cleared sediment and littoral vegetation predominantly from the dam's inlet during 2018 and enlarged the dam during this process.

Figure 3. Dam 1 on Portion 9 shown in 2009 (left) and in 2021 (right).

No environmental authorisations were obtained for the dams or the completed maintenance work in terms of the National Environmental Management Act or the National Water Act. The applicant discovered that authorisations should have been obtained when they made enquiries with Confluent Environmental regarding a WULA to abstract water from a new borehole. The landowner then voluntarily undertook to ensure their compliance with both Acts in terms of their water use.

1.2 Existing Lawful Use (ELU) of Water

In terms of the National Water Act (Act No. 36 of 1998), a comprehensive Validation and Verification (V & V) assessment was compiled by Confluent Environmental (2021) and was submitted to the BGCMA in August 2021. As the dams on Portion 1 and Portion 9 were constructed after the Qualifying Period between 1996 and 1998, they were excluded from the V & V. The proposed ELU for both Portions 4 and 9 are presented in Table 1.

Table 1. Proposed Existing Lawful Use for Portions 4 and 9 / 232 Redford Farm.

Farm Portion	Proposed ELU Section 21a (taking)	Proposed ELU Section 21b (storing)
Portion 4	36 764 m^3	3 315 m^3 (in two dams)
Portion 9	19 796 m^3	0

Redhaus Farm is not part of the Rondebosch River Water User Association and doesn't receive any allocated water through this system.

1.3 Present Storage of Water

The 4 dams were surveyed by SKB (Suid Kaap Besproeing) during October 2021. Measurements of the dams are provided in below. The present storage on Portion 4 is now 14 706.39 m3 (sum of Dams 2 and 4) which is 11 391.39 more than the ELU proposed (Table 1).

Table 2. Summary of dam survey results for four dams on Redhaus Farm.

Measurement	Dam 1	Dam 2	Dam 3	Dam 4
Total Volume (m^3)	17 552.41	4 659.39	5 805.62	10 047.00
Average Depth (m)	2.36	1.29	1.99	2.21
Surface Area (m^2)	7 859.14	4 101.95	3 067.07	4 879.57
Wall height (m)	4	2.5	2.9	4.4

1.4 Terms of Reference

- Conduct a desktop study that considers the site within the catchment context including a review of management and conservation of water resources and historical imagery;
- Visit the site to verify, classify, and assess affected watercourses at Redhaus Farm;
- Determine the Present Ecological State (PES), Ecological Importance and Sensitivity (EIS) and conservation significance of watercourses;
- Compile an aquatic specialist report that presents the findings of the desktop study and site visit, and an impact assessment including measures to mitigate further negative impacts related to maintenance of dams.

1.5 Assumptions and Limitations

- The retrospective nature of a Section 24g application has an inherent limitation in that listed activities / water uses have already occurred. Assessment of the ecological state of watercourses prior to the unauthorised activities is constrained by this factor. However, as far as possible, the pre-condition of aquatic ecosystems was inferred

through inspection of sites upstream and downstream, along with a comparison to historical satellite and aerial imagery.

- The landowner was able to provide historical photos of terrestrial areas prior to preparation of agricultural fields for planting of Almond orchards, but unfortunately no photos were available of watercourses. It is however, assumed that wide-scale alien invasion was present along the watercourses.
- This report is limited to aquatic habitats, and land use practices in terrestrial areas which can influence aquatic ecosystem health only. The present or historical ecological state of terrestrial areas is excluded from this report.

2. CATCHMENT CONTEXT

The site is in quaternary catchment **K60E** and all watercourses drain in a south-westerly direction directly into the Whiskey Creek River which is a tributary of the Keurbooms River (Figure 4).

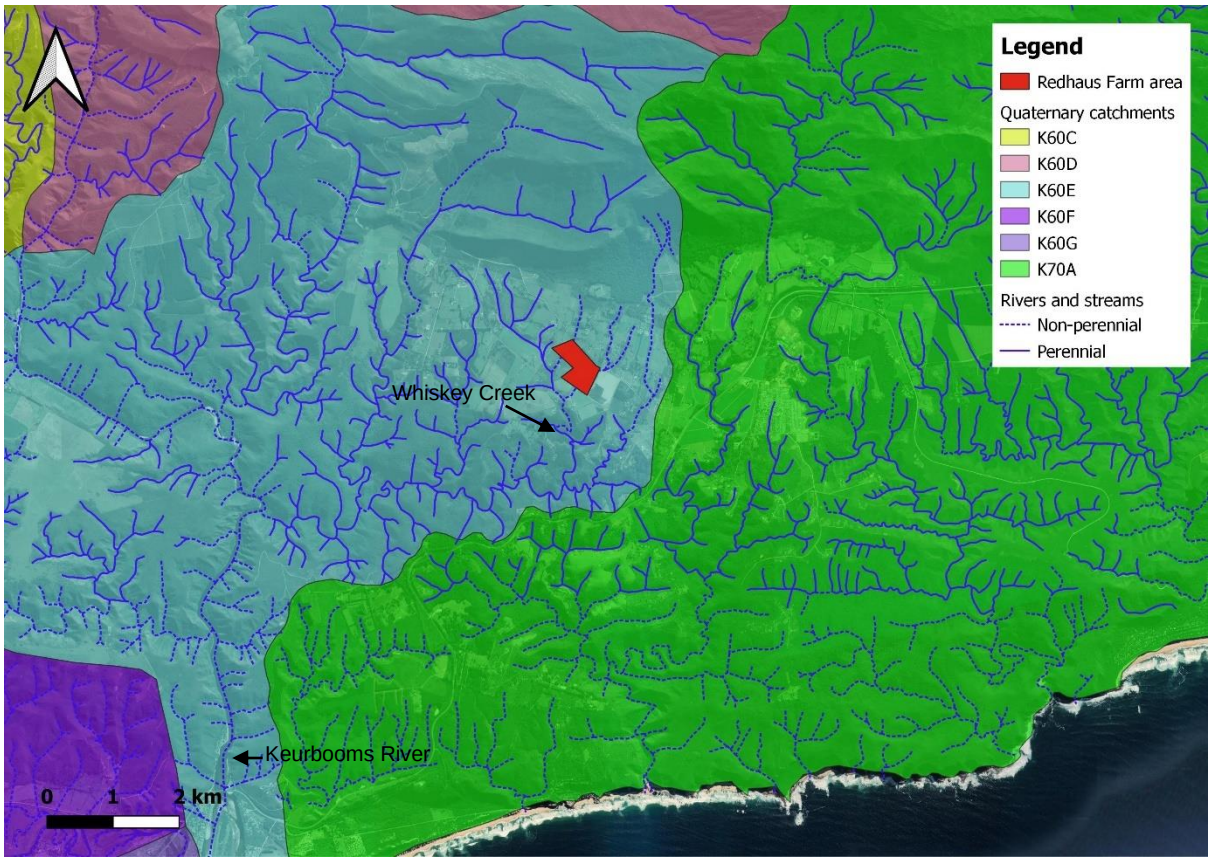


Figure 4. Redhaus Farm in relation to quaternary catchments and important rivers.

The mean annual rainfall is approximately 774 mm and the mean annual runoff is 101 mm. Rainfall seasons are bimodal with peaks in Autumn (March) and Spring (October; Figure 5).

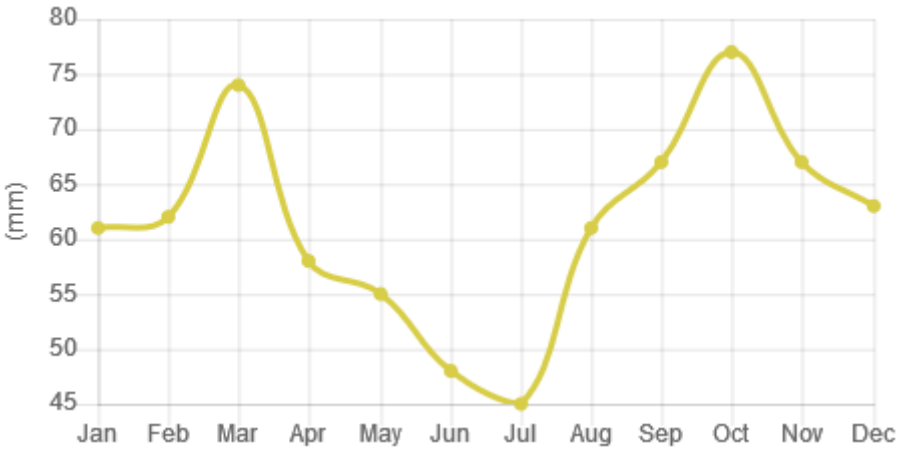


Figure 5. Monthly mean rainfall for the area.

2.1 Conservation

2.1.1 Western Cape Biodiversity Spatial Plan (WCBSP)

According to the WCBSP, watercourses on Redhaus Farm are classified as different levels of Ecological Support Areas (ESA; Figure 6). The definition and management objectives are provided below and correspond to Figure 6.

ESA1 Aquatic: Definition
Areas that are not essential for meeting biodiversity targets, but that play an important role in supporting the functioning of Protected Areas or Critical Biodiversity Areas and are often vital for delivering ecosystem services.
ESA1 Aquatic: Objectives
Maintain in a functional, near-natural state. Some habitat loss is acceptable, provided the underlying biodiversity, objectives and ecological functioning are not compromised.

ESA Restore: Definition
Areas that are not essential for meeting biodiversity targets, but that play an important role in supporting the functioning of Protected Areas or Critical Biodiversity Areas and are often vital for delivering ecosystem services.
ESA Restore: Objectives
Restore and/or manage to minimise impact on ecological processes and ecological infrastructure functioning, especially soil and water-related services, and to allow for faunal (animal) movement.

These management classes are consistent with aquatic water resources flowing through working agricultural areas, which are increasing in the Redford Farm area. However, the necessity to minimise impacts to water quality and habitat and support the movement of animals through aquatic systems must be preserved, maintained, and restored where necessary. The location of Redford Farm area between forested hills to the north and the Whiskey Creek Nature Reserve to the south increases the need for wildlife-supporting corridors through an increasingly fragmented landscape.

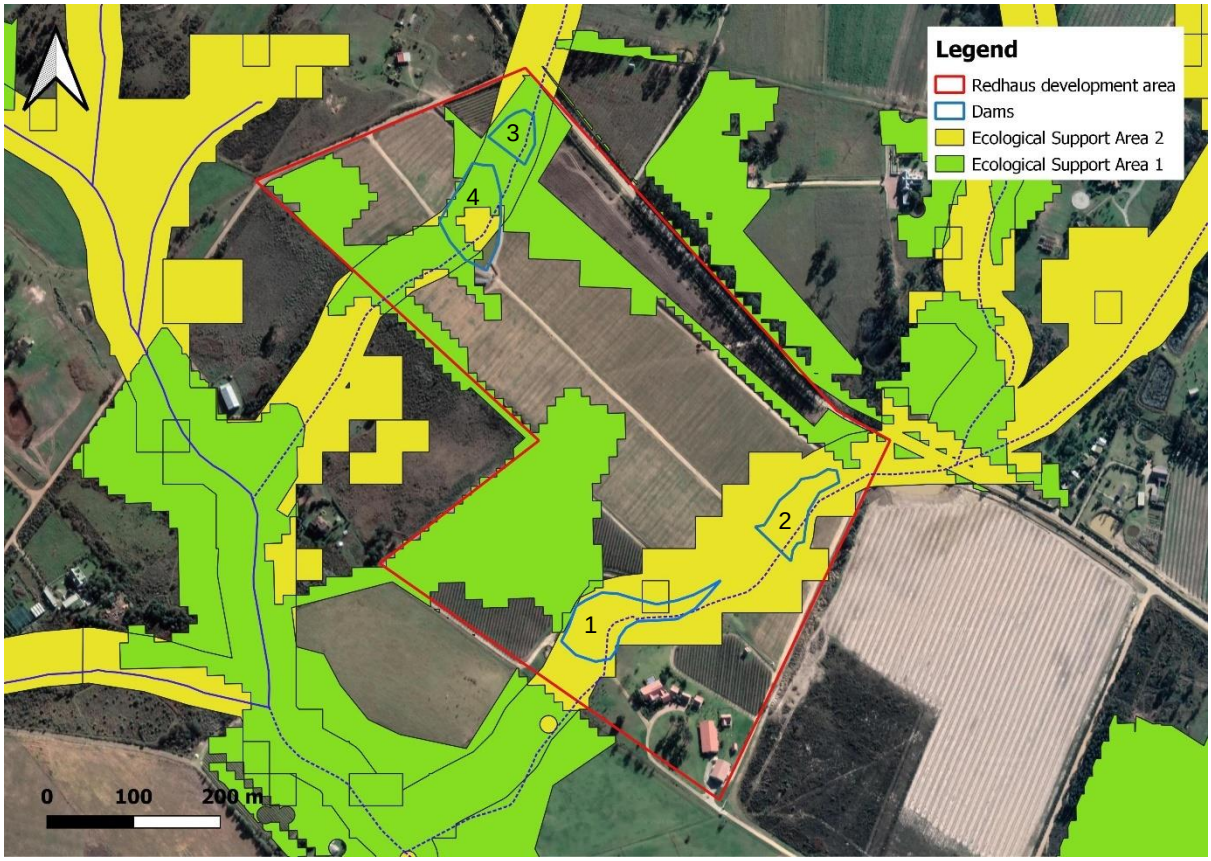


Figure 6. Map of dams (numbered) on Redhaus Farm in relation to areas mapped in the Western Cape Biodiversity Spatial Plan.

2.1.2 National Freshwater Ecosystem Priority Area (NFEPAs)

The watercourse is within NFEPA area (sub-quaternary reach) 9097, which is categorised as a **FEPA** (Freshwater Ecosystem Priority Area). A FEPA is an area prioritised for conserving freshwater ecosystems and associated biodiversity. The selection of FEPAs is determined through a process of systematic biodiversity planning using data on freshwater ecosystem types, species and ecological processes.

***Management Objectives*:** FEPAs should be maintained in a good condition to manage and conserve freshwater ecosystems and to protect water resources for human users. This does not mean that FEPAs should be fenced off from humans, but they should be supported by good planning, decision-making and management. **The recommended condition for all river FEPAs is an A or B ecological category** (Nel *et al*., 2011)..

2.1.3 Resource Quality Objectives (RQOs)

Resource Quality Objectives (RQOs) are defined as clear goals (numerical or descriptive statements) relating to the quality of a water resource and are set in accordance to the management class for the resource to ensure the water resource is protected. The purpose of RQOs is to set clear objectives for the resource against which water use licenses and the related impacts can be evaluated and managed to achieve a balance between the need to protect and utilise the resource. The Breede-Gouritz Catchment Management Agency

(BGCMA) recently concluded an assessment of major rivers in the Water Management Area (DWS, 2018).

The scale of assessment meant that smaller rivers and streams like Whiskey Creek were excluded, and the nearest relevant river system for Redhaus Farm would be Keurbooms River. The Keurbooms River has 3 endemic fish species which would be considered Species of Conservation Concern, *Pseudobarbus afer*, *Anguilla mossambica*, and *Sandelia capensis*. No exotic fish species have been recorded in the river, and no exotic fish species should be introduced anywhere in the catchment, especially in farm dams. The largest threats to endemic fish species is predation and habitat modification by exotic fish. High and low flows must be maintained according to levels prescribed in the RQOs. Water quality parameters such as nutrients, salts, and dissolved oxygen must be maintained at present levels (stipulated values in the RQOs). The cumulative impact of a catchment being transformed to more intensive agriculture (ie. Redford Farm area) can result in reduced water quality if the transformation is not well managed both during construction and operational phases.

2.2 Vegetation

The mapped vegetation type is Tsitsikamma Sandstone Fynbos which has a conservation status of **'Least Concern'**. A detailed description provided by SANBI (2018) is provided for this vegetation type in Appendix 1. This description also includes a list of plant species typically associated with this unit. While remnants of the vegetation type may have remained in isolated patches on Redhaus Farm prior to establishment of Almond orchards, there are no longer any areas of natural fynbos remaining on the property.

2.3 Historical Overview

A historical perspective of Redhaus Farm indicates that the property has been developed for small-scale agriculture for many decades. While it is evident that the dams are instream, the watercourses themselves were not clearly defined, and were probably small valley-bottom wetlands with intermittent surface flows.

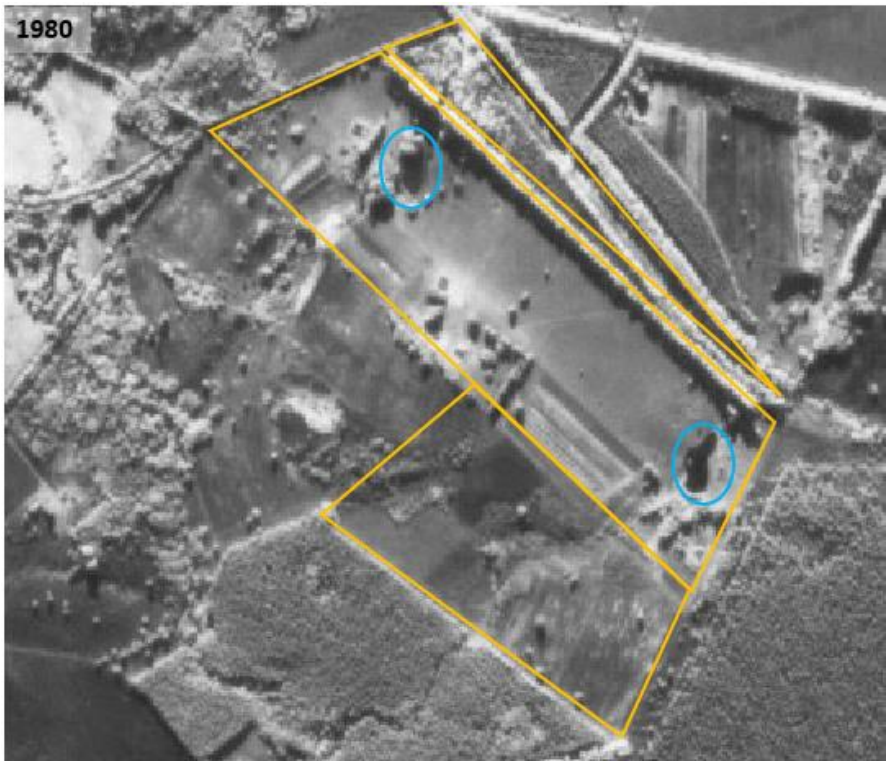


Figure 7. Aerial photo of the site from 1980 showing the two dams on portion 4, and no dams present on the other portions.

3. SITE ASSESSMENT

3.1 Site visit

The site was visited on 3 September 2021 which is considered early Spring. The weather was clear and there had been no significant rainfall in the preceding 24 hrs. Each of the dams on Redhaus Farm were inspected as well as watercourse features upstream and downstream. Relatively undisturbed dams on neighbouring farms were also inspected to give an indication of the type of aquatic vegetation that would have been present prior to removal for maintenance.

3.2 Watercourse classification

Classification of watercourses on the farm followed methods developed by Ollis *et al*. (2013) to classify wetlands and other aquatic ecosystems. The classification system accounts for diagnostic features such as the topographic setting and hydrology (depending on the wetland type).

The dams have each been constructed in one of two valley-bottom wetlands, which appear to be unchanneled, although the watercourses have been disturbed by vegetation clearing and enlargement of the dams (Table 3). This conclusion was reached following the site inspection as well as examining historical imagery of the site. The valley sides are relatively unconfined with gently sloping sides in most sections.

As indicated in Figure 8, water sources can originate from channelled inflow which may be restricted to periods of sufficient rainfall, overland inflow from valley sides, interflow through the soil on valley sides, and groundwater inflow in some cases.

Table 3. Summary of wetland hydrogeomorphic units at Redhaus Farm.

Wetland	Level 1	Level 2		Level 3	Level 4: HGM Unit
Unit	System	DWS Ecoregion	Vegetation	Landscape unit	Level 4
Western Wetland	**Inland**	Level 2 ecoregion 20.02 **South Eastern Coastal Belt**	SANBI Vegmap (2018): **Tsitsikamma Sandstone Fynbos** (Least Concern)	**Valley floor** Average slope 2.7%	**Unchannelled valley-bottom wetland** – a valley bottom wetland without a river channel running through it.
Eastern Wetland	**Inland**	Level 2 ecoregion 20.02 **South Eastern Coastal Belt**	SANBI Vegmap (2018): **Tsitsikamma Sandstone Fynbos** (Least Concern)	**Valley floor** Average slope 2.2%	**Unchannelled valley-bottom wetland** – a valley bottom wetland without a river channel running through it.

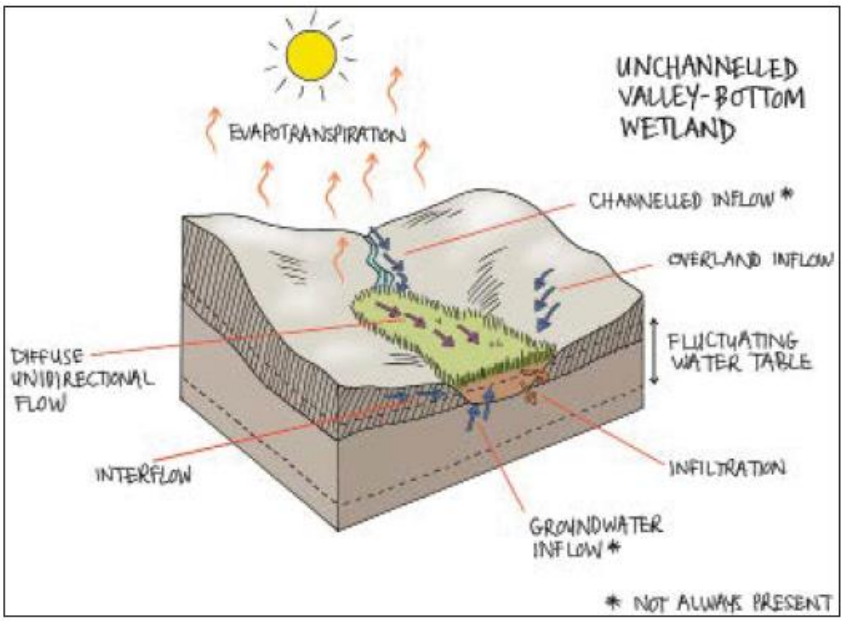


Figure 8. Conceptual illustration of the wetland type present at the site (from Ollis *et al*., 2013).

3.3 Riparian Buffers

Riparian means where the land meets a watercourse, and refers to the zone where these two habitats interface. Buffer areas are linear zones adjacent to watercourses managed with the intention of protecting water resources from diffuse pollution associated with adjacent land uses. In addition, they provide habitat for wildlife within, and as corridors throughout fragmented agricultural landscapes.

Prior to commencement of the Section 24G process, the landowner had already demarcated buffer zones around the dams and watercourses, and had commenced with revegetation using indigenous plants. A significant effort has been made to revegetate the riparian buffer along the western shore of Dam 1 as can be seen in Figure 10 which is an improvement on

the pre-condition of the site. This is a positive step, which will be improved upon by extending buffers to the width recommended in this report.

The width of buffer zones for Redhaus Farm was determined using the site-based model developed by Macfarlane & Bredin (2017) which is the more comprehensive of the two available models. The recommended buffers are mapped from the edge of the wetland area (DWAF, 2005).

The buffers recommended for both wetlands, including the dam areas, are **25 m** measured from the edge of the dam or wetland (Figure 9).

For buffer zones to be effective they will need to be revegetated following guidelines in Table 7 and using plants in Table 13.

Figure 9. Mapped wetland and dam areas showing the 25 m riparian buffer areas.

3.4 Present Ecological State (PES)

3.4.1 PES Pre-development

It is not possible to accurately determine the PES prior to the modifications listed in this report. As stated in the assumptions and exclusions, no photos of the site were available prior to clearance of vegetation and excavations. Based on discussions with the landowner, historical satellite images, and inspection of neighbouring dams, the following assumptions are made:

- There was extensive dumping of household rubbish and horse manure in the eastern wetland below Dam 1. This was removed by the landowner.
- Above and below the dams on all farm portions, widespread invasion of the wetland areas had taken place by Black Wattle. This is also evident in the historical image in Figure 2 and Figure 10.
- On Portion 1 and Portion 4 the dams contained dumped building rubble, mounds of plastic and other garbage. This was presumed to have been illegally dumped by building contractors and by squatters who had occupied derelict buildings on the site. This was all cleaned out and removed by the landowner.
- Despite these aspects of degradation, the amount of littoral and aquatic vegetation observable in the historical image of the dams on Portion 4 (Figure 2) suggest that the dams may have provided habitat for a range of biota (birds, macroinvertebrates, amphibians etc.).

While it is safe to say the wetlands were degraded prior to the unauthorised activities, the removal of all vegetation from Dams 2, 3, and 4, and wetland areas with heavy machinery reduced the opportunity for remnant indigenous flora and fauna to recover from more sensitive intervention methods. In this sense, one set of negative impacts have been replaced with another. The PES of the watercourse prior to development was therefore likely to be similar to what it is presently. The PES of Dam 1 may have been improved through the process of revegetation of large areas of shoreline with indigenous vegetation, and due to the fact that it was not excavated to the same extent as the other 3 dams.

Figure 10. Photos of Dam 1 taken in 2018 (left) and 2021 (right) showing the extent of alien vegetation compared to revegetation with indigenous plants.

The landowner has subsequently spent in the region of R387 000 on indigenous plants (many of which are listed in the recommended plant list in Table 13) which have been planted around primarily Dam 1 at this stage (Figure 10 and Figure 11). Future planting is planned for indigenous and wetland zones (including riparian buffers recommended in this report) which have been planned around the two watercourses. In this sense a reasonable degree of ecological structure and function (related to biodiversity) will be actively preserved and managed in the future, with further passive regeneration by flora and fauna expected to occur naturally from surrounding areas. It is therefore likely that the future ecological state of the wetlands will be an improvement on their pre-development state.

3.4.2 PES Methods

Wetlands on Redhaus Farm were assessed using the WET-Health model developed by Macfarlane (2008). Detailed methods for the assessment are provided in Appendix 2.

3.4.3 PES Results

The results of the PES assessment are summarised for each of the three modules in Table 4 and photos taken during the site visit are in Figure 11. The impacts affecting both wetlands are similar and relate to land use alongside each of them. The assessment of each wetland accounts incorporates impacts along their length from the Whiskey Creek Confluence up to the foothills to the north-east. **Both wetlands have a Present Ecological State of D, Largely Modified**. This status reflects that a large loss of natural habitat, biota and basic ecosystem functions has occurred. The WET-Health model does not have a water quality module. However, an added factor that must be considered in the PES assessment, and be included in the mitigation measures, is the high turbidity of water in the two upstream dams. This is partially related to runoff from the road, but also reflects recent disturbance related to clearing of dams and removal of vegetation both in the dam basin and along slopes above the dams for establishment of Almonds. Serious disturbance (dam-building and channel straightening) in the Eastern Wetland on the property neighbouring Redhaus Farm has also caused a decline in water quality in Dam 2 through increased turbidity.

Table 4. PES assessment for the Eastern and Western wetlands on Redhaus Farm including the upper catchment up to the confluence with Whiskey Creek.

Western Wetland PES	Eastern Wetland PES
1. HYDROLOGY	**1. HYDROLOGY**
Significant abstraction of surface water from instream dams	Extensive abstraction of surface water from instream dams
Minor increase in flows due to stormwater and borehole storage	Minor increase in flows due to stormwater from roads
Reduction in flood peaks due to numerous instream dams	Reduction in flood peaks due to numerous instream dams
Reduced roughness due to cultivation of fields	Reduced roughness due to cultivation of fields
Hydrology PES Category: E, Seriously Modified	**Hydrology PES Category: E, Seriously Modified**
2. GEOMORPHOLOGY	**2. GEOMORPHOLOGY**
Infilling due to roads, dams and embankments approx. 10%	Infilling due to roads, dams and embankments approx. 15%
Deposition due to erosion from road and cultivated lands	Deposition due to erosion from road and cultivated lands
Increase runoff due to vegetation clearance and cultivated lands	Increase runoff due to vegetation clearance and cultivated lands
Geomorphology PES Category: B, Largely Natural	**Geomorphology PES Category: B/C, Largely Natural to Moderately Modified**
3. VEGETATION	**4. VEGETATION**
Loss due to infrastructure like dams, roads, and gardens	Loss due to infrastructure like dams, roads, and gardens
Shallow and deep flooding of vegetation by dams	Shallow and deep flooding of vegetation by dams
Transformation from indigenous vegetation to agriculture	Transformation from indigenous vegetation to agriculture
Vegetation PES Category: E, Seriously Modified	**Vegetation PES Category: D, Largely Modified**
OVERALL PES: D, Largely Modified	**OVERALL PES: D, Largely Modified**

Western Wetland

The total wetland area assessed measured approximately 7.2 ha from the source to the confluence of Whisky Creek. The portion within Redhaus Farm measured 1.6 ha, or **22%** of the wetland area. The wetland has been dammed at four points along its length, including the two dams at Redhaus Farm. This has an important effect on hydrology because it reduces base flows, flood peaks and flood frequencies. If this was on one tributary only, the impact would be manageable, however, the cumulative impacts of extensive damming on all tributaries of the Whiskey Creek will result in increasing periods of low to no flows.

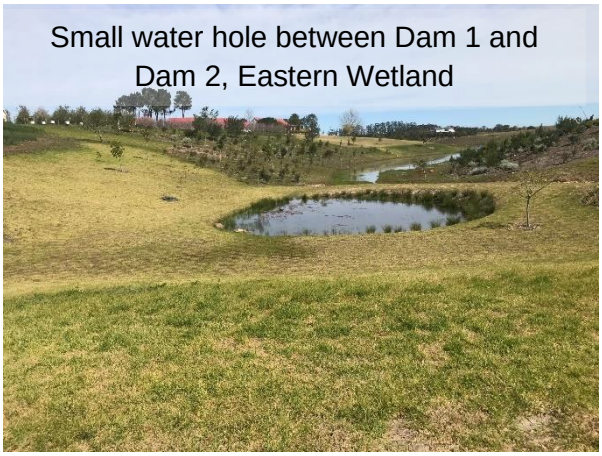
Infilling across the wetland areas has occurred due to the main Redford Road, and at each point where a dam wall has been constructed. Dams in the Western Wetland are fairly shallow at approximately 2 m average depth. This will still allow the regeneration of extensive rooted macrophytes over time.

Eastern Wetland

The total wetland area assessed measured in the region of 12.2 hectares from the source area to the confluence with Whiskey Creek. The portion on Redhaus Farm is approximately 2 ha, totalling about **16%** of the wetland area. This wetland has been dammed approximately 18 locations which has had a significant impact on habitat, hydrology and wetland vegetation.

In addition to the two dams on Redhaus Farm, the neighbouring property has recently (in 2020 or 2021) constructed a small instream dam and diverted stormwater from the road into the watercourse above the Redhaus Dam. This has resulted in very high turbidity of the water and will lead to rapid sedimentation and volume reduction of the dam on Redhaus Farm.

Dam 1: Eastern Wetland



Small water hole between Dam 1 and Dam 2, Eastern Wetland

Dam 2: Eastern Wetland

Dam 3: Western Wetland

Figure 11. Photos of watercourse areas at Redhaus Farm showing various aspects of the dams.

3.5 Ecological Importance and Sensitivity (EIS)

3.5.1 EIS Methods

The methods used to determine the Ecological Importance and Sensitivity of wetlands at Redhaus Farm are provided in detail in Appendix 3.

3.5.2 EIS Results

The results of the EIS assessment are presented in Table 5 and determined that the wetlands at Redhaus Farm are of VERY HIGH importance and sensitivity. Summarised motivation for this finding is provided in the assessment. While the level of confidence in the presence of Red Data species is low, it is likely that rare or unique specie were / are present in the wetlands under reference (pre-impact) conditions. The wetlands are important corridors of more natural, protected and diverse vegetation linking the forested hill areas to the north with the Whiskey Creek Nature Reserve to the south. As the level of transformation of surrounding land increases in Redford Farm area, so the importance of watercourses as a corridor for wildlife increases. The wetlands both play an important role in the maintenance of base flows in the Whiskey Creek as they provide the slow release of water as it moves through the wetland soil, which also acts as a large filter to remove pollutants and sediment. ***The management objective for wetlands with a Very High EIS is to improve their PES***.

Table 5. Ecological Importance and Sensitivity of the Eastern and Western Wetlands at Redhaus Farm and the greater catchment.

Ecological importance and sensitivity	Score 0-4	Confidence 1-5	Motivation
Biodiversity support	**3**		
Presence of Red Data species	4	2	Ideal habitat for *A. knysnae*
Populations of unique species	2	2	Quite likely unique species present
Migration/feeding/breeding sites	3	4	Important link between hills and WC NR
Landscape scale	**2.2**		
Protection status of wetland	3	4	Privately owned land
Protection status of vegetation type	1	3	Least Concern
Regional context of the ecological integrity	2	3	Many similar wetlands in Redford, but all threatened by agriculture
Size and rarity of the wetland types present	2	3	Small UVBs and relatively common in the area
Diversity of habitat types	3	3	Fairly diverse under reference conditions
Sensitivity of the wetland	**3.3**		
Sensitivity to changes in floods	3	3	UVBs sensitive to high velocity channelled flows
Sensitivity to changes in low flows	3	4	Small wetlands are more sensitive
Sensitivity to changes in water quality	4	4	Most biota adapted to good water quality
Hydrofunctional Importance	**2.6**	**3**	**Flood attenuation and streamflow regulation especially NB for WC NR.**
Direct human benefits	**1.5**	**3**	**Tourism, endemic frog research, water for human use**
ECOLOGICAL IMPORTANCE AND SENSITIVITY (EIS)	**3.3**	**VERY HIGH**	

4. IMPACT ASSESSMENT AND MITIGATION MEASURES

4.1 Methods

The complete methods used for the impact assessment are provided in Appendix 4. Given that the activities under assessment have already taken place, namely the enlargement and maintenance of dams, it is not possible to assess the construction phase of the development. Therefore, the impact assessment is focussed on the operational phase where each pre-mitigation impact provides a measure of the impact the activity has had.

4.2 Impact Assessment

4.2.1 Operational Phase: Dam Maintenance

The present impact of dam maintenance should be avoided in the future. Dams must not be enlarged from their current size. Further mitigation measures are listed in Table 6.

Table 6. Operational phase impact of future dam maintenance.

Project phase	**Operation**			
Impact	**Clearance of vegetation in littoral, riparian and wetland areas for maintenance of dams**			
Description of impact	**Habitat loss for aquatic and terrestrial wildlife, mortalities to various species unable to evade the disturbance, loss of viable propagules (eggs and seeds), fragmentation of ecological infrastructure**			
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts		
Potential mitigation	**• Ensure erosion is controlled in the catchment zone of each dam. This will reduce the need for frequent silt removal from dams. This can be achieved through the temporary installation of hay bale check dams, or silt fencing during periods of disturbance. • Dam volumes must be maintained during maintenance and the size of the dam may not be increased. • Prior to maintenance, encourage dense growth of wetland vegetation at the inflow area (filter zone) of each dam to trap sediments and reduce their transport into dams. This should be an ongoing practice and will form part of the rehabilitation of wetlands and buffer zones at Redhaus Farm. Vegeatation cover must be 100% in the filter zone. • Access by heavy machinery used to remove sediment must be limited to a maximum of two discrete locations. One from the dam wall, and the other from the side of the dam. This is to limit the footprint of disturbance and compaction of soil. • Disturbed riparian areas must be rehabilitated and replanted with suitable indigenous vegetation following access with heavy machinery. • As far as possible try not to disturb fringing littoral vegetation and concentrate silt removal from the main basin of the dam. If vegetation must be removed, then a maximum of 50% of emergent vegetation can be removed. This vegetation can be replanted in suitable areas where more dense wetland vegetation is desireable such as the filter zones. Alternatively, it can be left to dry out next to the dam for a few days so that any associated biota can find their way back to the dam. • Maintenance to remove silt must not take place during the breeding season (Sep - Feb). • Silt removal is preferably done when water levels in the dam are very low.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	Long term	Impact will last between 10 and 15 years	Short term	Impact will last between 1 and 5 years
Extent	Limited	Limited to the site and its immediate surroundings	Very limited	Limited to specific isolated parts of the site
Intensity	Very high	Natural and/ or social functions and/ or processes are majorly altered	Low	Natural and/ or social functions and/ or processes are somewhat altered
Probability	Almost certain / Highly probable	It is most likely that the impact will occur	Rare / improbable	Conceivable, but only in extreme circumstances, and/or might occur for this project although this has
Confidence	High	Substantive supportive data exists to verify the assessment	Medium	Determination is based on common sense and general knowledge
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	High	The affected environment will be able to recover from the impact
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Low	The resource is not damaged irreparably or is not scarce
Significance	**Moderate - negative**		**Negligible - negative**	
Comment on significance				
Cumulative impacts	Given the high number of dams in Redford there is a considerable cumulative impact on habitat, sensitive species, and water quality if all land-owners fail to follow these mitigation guidelines.			

4.2.2 Operational Phase: Establish riparian buffer zones

A buffer of 25 m is specified for protection of the full length of the Eastern and Western wetlands, which includes the dam areas, and extends from the edge of mapped watercourses. Establishment and mitigation measures are listed in Table 7.

Table 7. Operational phase impacts for the establishment of riparian buffer zones.

Project phase	**Operation**			
Impact	**Establishment of riparian buffer zones**			
Description of impact	**Restoration of habitat, biodiversity support, water quality and wildlife corridors**			
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts		
Potential mitigation	**• Begin with the establishment of 25 m buffer areas by marking them out using stakes, stones, danger tape etc. Buffers have been mapped in this report, and are measured from the edge of wetlands and dams. • As far as possible, roads and orchards must be kept out of riparian buffer zones. Where existing orchards and roads have been established (e.g. West of Dam 1) buffer zones must be established as far as possible beyond these areas. No new infrastructure should encroach into mapped buffer zones. • Buffer areas should aim for at least 80% vegetation cover with a complex of growth forms able to intercept overland flows. • Ensure that staff and contractors area aware that there are unique conditions and guidelines for the mangement of these areas. • Select appropriate vegetation for establishment from the list of species provided. The more diverse the better. Vegetation can be sourced from wholesale nurseries, cuttings or seed. • Do not mow / remove any establishing indigenous vegetation in buffer areas. • Staff must be trained to identify weeds. Indigenous grasses are beneficial in riaparian zones and should not be removed. (e.g. removing indigenous grasses is detrimental as they provide good coverage in buffer areas). Weeds that must be removed are recognised alien invaders such as Black Wattle, Blackwood, Bugweed etc. Staff must be trained to identify these plants. • Kikuyu grass is an alien invasive species that will limit the success of riparian buffer planting. It must therefore be systematically removed in sections. This can be achieved by spraying it off with a suitable herbicide on hot, dry, windless days where spray drift will not extend to sensitve aquatic areas. • Kikuyu can be prevented from re-establishment using borders of gravel, bark, or logs which can be moved back each time a section is removed for replanting.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Positive	
Duration	Medium term	Impact will last between 5 and 10 years	On-going	Impact will last between 15 and 20 years
Extent	Local	Extending across the site and to nearby settlements	Local	Extending across the site and to nearby settlements
Intensity	High	Natural and/ or social functions and/ or processes are notably altered	High	Natural and/ or social functions and/ or processes are notably altered
Probability	Almost certain / Highly probable	It is most likely that the impact will occur	Almost certain / Highly probable	It is most likely that the impact will occur
Confidence	High	Substantive supportive data exists to verify the assessment	High	Substantive supportive data exists to verify the assessment
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	High	The affected environment will be able to recover from the impact
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Low	The resource is not damaged irreparably or is not scarce
Significance	**Minor - negative**		**Moderate - positive**	
Comment on significance	Without establishment of riparian buffer zones the impact will be negative, while the opposite is true if they are established effectively.			
Cumulative impacts	Without establishment of riparian buffers the cumulative impact of vegetation loss would represent a significant fragmentation of riparian habitat across the two wetlands.			

4.2.3 Operational Phase: Wetland rehabilitation

Wetland areas above, between and below the 4 dams must be rehabilitated following the methods stipulated in Table 8. These areas are mapped and indicated in Figure 12.

Table 8. Operational phase impact of rehabilitating wetlands.

Project phase	**Operation**			
Impact	**Wetland rehabilitation**			
Description of impact	**Restoration of wetland vegetation to improve structure, function and habitat diversity**			
Mitigatability	Medium	Mitigation exists and will notably reduce significance of impacts		
Potential mitigation	**• All staff must be made aware that wetland areas are sensitive and should be avoided, which includes mowing of vegetation. • No heavy machinery or vehicles can be driven into wetland areas. • Any existing roads that have been established through wetlands areas or their buffers must be re-routed and rehabilitated. • Only suitable wetland vegetation must be planted in these areas as terrestrial plants will perish due to the saturated soils. • The aim in wetland areas is to achieve 100% cover with suitable indigenous wetland plants in the wetland area. • The Western Wetland below Dam 4 has a fair amount of naturally present vegetation and adjoins a neighbouring area with extensive wetland vegetation. Rehabilitation in this area can therefore take a more passive approach with less active planting. • Extensive kikuyu grass is present in the wetland area below Dam 1 and Dam 4. This must be manually removed in sections and will need active replanting with wetland adapted species below Dam 1. • Water releases that take place from dams upstream must be done at vey low velocities so as not to develop channels through the wetland habitat. This will result in incision and draining of wetland habitat which is highly detrimental to this wetland type. Outflow areas should be protected with rock and dense vegetation to reduce and scour effect. • Work with neighbours upstream and downstream to improve connectivity in habitat (mainly vegetation) and for the movement of wildlife through fencelines. • The waterhole between Dam 1 and Dam 2 must be completely surrounded by dense vegetation as this would be ideal habitat for Knysna leaf-folding frogs.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Positive	
Duration	Medium term	Impact will last between 5 and 10 years	On-going	Impact will last between 15 and 20 years
Extent	Local	Extending across the site and to nearby settlements	Local	Extending across the site and to nearby settlements
Intensity	High	Natural and/ or social functions and/ or processes are notably altered	High	Natural and/ or social functions and/ or processes are notably altered
Probability	Almost certain / Highly probable	It is most likely that the impact will occur	Almost certain / Highly probable	It is most likely that the impact will occur
Confidence	High	Substantive supportive data exists to verify the assessment	High	Substantive supportive data exists to verify the assessment
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	Medium	The affected environment will only recover from the impact with significant intervention
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Medium	The resource is damaged irreparably but is represented elsewhere
Significance	**Minor - negative**		**Moderate - positive**	
Comment on significance	Without rehabilitation of wetlands, they willl be permanantly altered with a negative impact. Rehabilitation will result in a positive impact.			
Cumulative impacts	The cumulative impacts across both wetland systems would be significant if they are not impacted due to framentation and loss of this sensitive habitat type.			

Figure 12. Wetland areas to be rehabilitated on Redhaus Farm.

4.2.4 Operational phase: Managing dam infrastructure

Recommendations to mitigate the negative impacts anticipated from dam infrastructure are presented in Table 9.

Table 9. Operational phase impacts for the management of dam structures.

Project phase	**Operation**			
Impact	**Management of Dam Structures**			
Description of impact	**Revegetation of dam walls, spillways and outflow points**			
Mitigatability	High	Mitigation exists and will considerably reduce the significance of impacts		
Potential mitigation	**• No trees or large shrubs must be planted on dam walls. • To improve connectivity and the biodiversity value across each of the watercourses, aim to diversify the plant species establshed on dam embankments. These species must effectively hold the soil and prevent erosion. Indigenous grass sepcies such as Kweek (Cynodon dactylon) are effective in conjunction with scrambling plants such as Helichrysum petiolare and various Plectranthus spp and Carprobrotus spp. • In the event of the dams overflowing, their spillways are well protected by rock, which can be further supported by dense interplanting with indigenous plants. This has been implemented on Dam 1 and 2, and is planned for Dam 3 and 4. This will further reduce flow velocities with the aim of preventing damage to wetland areas downstream. • Any outflow areas from dams must be protected by rock and dense vegetation for at least 3 m below. This is also to reduce any scour effect from damaging sensitive wetland habitat.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Positive	
Duration	Short term	Impact will last between 1 and 5 years	Long term	Impact will last between 10 and 15 years
Extent	Very limited	Limited to specific isolated parts of the site	Very limited	Limited to specific isolated parts of the site
Intensity	Low	Natural and/ or social functions and/ or processes are somewhat altered	Moderate	Natural and/ or social functions and/ or processes are moderately altered
Probability	Likely	The impact may occur	Almost certain / Highly probable	It is most likely that the impact will occur
Confidence	High	Substantive supportive data exists to verify the assessment	High	Substantive supportive data exists to verify the assessment
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	Medium	The affected environment will only recover from the impact with significant intervention
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Medium	The resource is damaged irreparably but is represented elsewhere
Significance	**Negligible - negative**		**Minor - positive**	
Comment on significance	Without interventions to improve the diversity and density of vegetation it will recovery will be constrained, however with active replanting a signficant improvement can be achieved.			
Cumulative impacts	Not applicable.			

4.2.5 Operational phase: Orchard management for the protection of water resources

While the present and future orchards are not located in watercourses, aspects of their management and operation can potentially impact on water resources. These are considered along with recommended mitigation measures in Table 10. It is positive to note that many of these measures are already being implemented through a regenerative agricultural approach in existing orchards at Redhaus Farm (e.g. existing Integrated Pest Management Plan, precision farming techniques). This section is nonetheless included to reiterate the need for best practice methods to continue through the development of future orchards

Table 10. Operational phase impacts associated with orchard management

Project phase	**Operation**			
Impact	**Management of orchards for the protection of water resources and improved biodiversity**			
Description of impact	**Use of pesticides, planting orchard floors, orchard layouts**			
Mitigatability	Medium	Mitigation exists and will notably reduce significance of impacts		
Potential mitigation	**• Should rows of windbreak trees be required for the protection of Almond trees, or along borders, consider the use of valuable indigenous trees such as nitrogen-fixing Keurbooms (Virgilia spp.) which will attract natural enemies of insect pests. • Species composition of the orchard floor is one aspect of IPM which can also improve the runoff quality of water from the orchard during rainfall events. A diverse, dense assemblage of indigenous grasses and forbs provides habitat for insect pests which will occupy this area instead of feeding on the trees. The other benefit of a dense orchard floor cover is the reduction of flow velocities during surface runoff, which will reduce soil loss and erosion. While kikuyu grass is very dense and fast growing, it has little biodiversity value and is invasive. It would be preferable to introduce additional species such as Cynodon dactylon (Bermuda grass), Tephrosia capensis (a nitrogen fixing legume), Tristachya leucothrix (Hairy trident grass) and Eragrostis capensis (hartjiesgras). • Develop an Integrated Pest Management Plan (IPM) with the assistance of a consultant (if there isn't one already). The aim is to ensure that the correct pesticides are applied at the lowest possible rates and non-target impacts in terrestrial and aquatic habitats are kept to a minimum. • Consider the need and impact of fencing. It can greatly fragment the landscape limiting the movement of wildlife. If orchards require protection from animals such as bushpigs, an alternative would be to run three strands of electrical fencing around fields starting at 40cm up to 1 m height. This willl still allow tortoises movement below the lowest strand. Fencing across watercourses must allow for the movement of wildlife.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Negative	
Duration	On-going	Impact will last between 15 and 20 years	Short term	Impact will last between 1 and 5 years
Extent	Limited	Limited to the site and its immediate surroundings	Limited	Limited to the site and its immediate surroundings
Intensity	Moderate	Natural and/ or social functions and/ or processes are moderately altered	Very low	Natural and/ or social functions and/ or processes are slightly altered
Probability	Almost certain / Highly probable	It is most likely that the impact will occur	Unlikely	Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur
Confidence	Medium	Determination is based on common sense and general knowledge	High	Substantive supportive data exists to verify the assessment
Reversibility	High	The affected environment will be able to recover from the impact	Medium	The affected environment will only recover from the impact with
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Medium	The resource is damaged irreparably but is represented elsewhere
Significance	**Minor - negative**		**Negligible - negative**	
Comment on significance	Extensive fragmentation through fencing will restrict wildlife movement and reproductive success, excessive use of pesticides can impact negatively on sensitive aquatic biota such as frogs.			
Cumulative impacts	Increasing use of fencing in Redford Farm will result in a fragmented and essentially sterile habitat for wildlife.			

4.2.6 Operational Phase: Ecological Water Requirements

The necessity to ensure the maintenance of downstream ecological water requirements as stipulated by the National Water Act is considered in this section. An impact assessment table was not completed because the only mitigation is to either decommission the dams or release a set quantity of water downstream. The former is assessed in the following section, and the latter is not recommended for the following reasons.

There are dams 150 - 200m downstream of both Dam 1 and Dam 4 on neighbouring properties. Ecological Water Releases would therefore flow straight into the neighbouring

dams without reaching the Whiskey Creek further downstream. This would defeat the objective of releasing flows to sustain the Whiskey Creek unless the dams downstream were subject to the same EWR releases and a catchment-based approach is followed.

Dam 4 has an outlet, which is used periodically to release water downstream to sustain the neighbour's dam. The landowner of Redhaus Farm has a gentleman's agreement to this effect, and a number of releases have already been made.

The wetland hydrology upstream and downstream of the dams is not greatly affected as they still maintain zones of permanent and seasonal saturation, despite the presence of the dams. As unchanneled valley-bottom wetlands, channelled flow (e.g. from an outlet) is undesirable as it leads to channel incision and ultimately draws down the water table. The results of the hydrological assessment (Confluent Environmental 2021) indicate there is a slight reduction in mean annual runoff from the Whiskey Creek catchment, and that reductions occur during peak high flow conditions. The same assessment indicated that no reductions were estimated during low flow periods,

Based on the points above, the need for EWR releases is not considered high in this situation unless it is conducted from a catchment-wide perspective.

4.2.7 Decommissioning Phase: Removal of Dams

Two options are possible when considering the decommissioning phase, the removal of dams and / or the reduction of dam volumes to ELU levels.

1. **Removal of Dams**

The two dams on Portion 9 and new section of Portion 1 respectively were not constructed during the Qualifying Period, and it could therefore be motivated that they be removed. However, as the current landowner purchased the properties with the dams already constructed, the present farm layout was based on the water storage present, and the farm portions were purchased because they had dams which could be used for irrigating the planned orchards.

The impacts of removing dams in their mitigated state are considered a negligible positive (Decommissioning phase impacts of the removal of dams.). It will be challenging, if not impossible, to restore the wetland features originally present, because the soil profile is one of the main drivers and the soil has now been homogenised (mixed up) and / or removed. While the vegetation can be restored to indigenous vegetation of a high cover in the original dam basin, the main benefit would be improved flood pulses reaching the watercourses downstream, including Whiskey Creek.

Table 11. Decommissioning phase impacts of the removal of dams.

Project phase	**Decommissioning**			
Impact	**Removal of unlawful dams**			
Description of impact	**Further disturbance, but restoration of habitat and hydrology a positive**			
Mitigatability	Medium	Mitigation exists and will notably reduce significance of impacts		
Potential mitigation	**• Remove the embankment material and spread it across the dam basin, levelling it as far as possible to the natural gradient of the watercourse. • Any concrete must be removed from the site and disposed of appropriately, not buried or dumped in the watercourse. • Reshaping of the watercourse must achieve alignment with the elevation of the bed at the inflow and outflow areas. • A layer of topsoil approximately 50 cm deep must be placed across the surface of the disturbed area of the dam basin. • The disturbed area must be revegetated using suitable indigenous plants as listed in this report. Vegetation cover must be at least 80%. • Exposed slopes must be protected with soil saver matting until vegetation has fully established. • The watercourse must be monitored for erosion following rainfall, and eroded sections must be rehabilitated by revegation supported with soil save matting or silt fencing. • This work must be overseen by an aquatic ecologist.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Negative		Positive	
Duration	Short term	Impact will last between 1 and 5 years	Medium term	Impact will last between 5 and 10 years
Extent	Limited	Limited to the site and its immediate surroundings	Limited	Limited to the site and its immediate surroundings
Intensity	High	Natural and/ or social functions and/ or processes are notably altered	Moderate	Natural and/ or social functions and/ or processes are moderately altered
Probability	Likely	The impact may occur	Unlikely	Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur
Confidence	Medium	Determination is based on common sense and general knowledge	Medium	Determination is based on common sense and general knowledge
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	Medium	The affected environment will only recover from the impact with significant intervention
Resource irreplaceability	Medium	The resource is damaged irreparably but is represented elsewhere	Medium	The resource is damaged irreparably but is represented elsewhere
Significance	**Minor - negative**		**Negligible - positive**	
Comment on significance	The pre-mitigation impact assumes the dam wall is removed without any subseqent rehabilitation.			
Cumulative impacts	More water would be available through the system, which would provide more sustantial flows downstream.			

4.2.8 Decommissioning phase: reduction of dam volumes

2. Reduction of dam volumes to ELU level

The two dams on Portion 4 were constructed prior to the Qualifying Period and therefore have a small volume of water that qualifies as an Existing Lawful Use. The expansion of these dams was undertaken by the current landowner and was in response to additional water requirements for irrigating the planned Almond orchards. It is therefore possible that regulating authorities may instruct the landowner to reduce the dam volumes to the ELU levels. In this case however, the full extent of the planned Almond Orchards would not be feasible.

From an economic perspective the removal of dams or reduction of water levels will have a significant negative impact on Almond production at Redhaus Farm. From an aquatic ecology perspective, reducing the dam volumes in either the pre- or post-mitigation state would be seen as a minor positive impact (Table 12). The impact is not considered more significant, because in its reference state the watercourse does not have perennial flows, and wetland features are still present downstream of the dams. While the additional water release may contribute to improved hydrology in the Whiskey Creek, the level of modification to the entire system in terms of hydrology is already significant.

Table 12. Decommissioning phase impacts of reducing dam volumes to ELU levels.

Project phase	**Decommissioning**			
Impact	**Reduction of dam volumes to ELU level**			
Description of impact	**Improve flows reaching the watercourse downstream**			
Mitigatability	Medium	Mitigation exists and will notably reduce significance of impacts		
Potential mitigation	**• Water levels in the dam can be reduced a number of ways including the installation of siphons, opening of outlets etc. The most certain way to restrict the storage volume is to reduce the height of the spillways. This could be achieved using machinery positioned on the dam wall. • The slope of the spillway would need to be re-sloped to a gradient of 1:3 with protection along the spillway maintained to prevent erosion. • Dam banks above the reduced high water mark would need to be revegetated to incorporate the area into the riparian buffer zone. Planting should utilise the species indicated in this report.**			
Assessment	**Without mitigation**		**With mitigation**	
Nature	Positive		Positive	
Duration	Long term	Impact will last between 10 and 15 years	Long term	Impact will last between 10 and 15 years
Extent	Limited	Limited to the site and its immediate surroundings	Limited	Limited to the site and its immediate surroundings
Intensity	Low	Natural and/ or social functions and/ or processes are somewhat altered	Moderate	Natural and/ or social functions and/ or processes are moderately altered
Probability	Likely	The impact may occur	Almost certain / Highly probable	It is most likely that the impact will occur
Confidence	Medium	Determination is based on common sense and general knowledge	High	Substantive supportive data exists to verify the assessment
Reversibility	Medium	The affected environment will only recover from the impact with significant intervention	Medium	The affected environment will only recover from the impact with significant intervention
Resource irreplaceability	Low	The resource is not damaged irreparably or is not scarce	Low	The resource is not damaged irreparably or is not scarce
Significance	**Minor - positive**		**Minor - positive**	
Comment on significance	The pre- and post-mitigation impacts are similar resulting in the same cateogry.			
Cumulative impacts	Not applicable			

5. REVEGETATION PLAN

Substantial progress has already been made with indigenous revegetation around dams (especially Dam 1) and on dam embankments over the past 3 years. The landowner has invested considerable funds to purchase and plant indigenous vegetation and had already developed a management plan which identified the areas around each watercourse as 'indigenous zones' to be revegetated.

The selection of plants is based on what is easy to obtain from nurseries, grow from cuttings or germinate from seed (Table 13). Additional species listed under 'Important Taxa' or 'Endemic Taxa' in the description of the vegetation type (Appendix 1) can also be used if they can be sourced. No alien aquatic weeds must be introduced to dams which include Kariba Weed and Water Hyacinth among others.

It is understood that revegetation of a 25 m strip of land along the length of each wetland is an extensive undertaking. It is therefore recommended that the project be broken up into 5 m – 10 m strips along each watercourse working from the water's edge outward. The best time to establish plants is in early spring (September and October).

It is not necessary to plant too many trees, as the original vegetation was fynbos. The planting plan should be staggered and varied to simulate natural distribution of plants with lower plants near the water's edge, grading to taller vegetation. Vegetation cover should aim for 80% cover.

Table 13. Indigenous plant species for different areas where active planting is required on Redhaus Farm.

Species name	Common name	Riparian Buffer	Wetland	Dam wall
Trees				
Ekebergia capensis	Cape Ash	✓		
Halleria lucida	Tree fuchsia	✓		
Osteospermum moniliferum	Bitou	✓		
Searsia undulata	Kuni-bush	✓		
Searsia glauca	Blue kuni-bush	✓		
Buddleja salviifolia	Sagewood	✓		
Buddleja Saligna	False olive	✓		
Tarchonanthus littoralis	Coastal camphorbush	✓		
Virgilia oroboides	Keurboom	✓		
Podocarpus latifolius	Yellowwood	✓		
Shrubs				
Agathosma recurvifolia	Boegoe	✓		
Helichrysum petiolare	Licorice plant	✓		✓
Leucospermum glabrum	Pin cushion	✓		
Psoralea axillaris	Violet-flash fountainbush	✓	✓	
Watsonia knysnana	Narrow watsonia	✓		
Selago corymbosa	Stiff bitterbush	✓		✓
Pelargonium cordifolium	Heartleaf storksbill	✓		✓
Pelargnoium citronellum	Lemon-scented pelargonium	✓		✓
Wachendorfia thyrsiflora	Marsh butterfly lily		✓	
Cliffortia strobilifera	Cape stock rose	✓	✓	

Cliffortia odorata	Wild vine (can take over)		✓	
Aristea spp.	Blue brilliant	✓		✓
Juncus effusus	Soft rush		✓	
Juncus kraussii	Sharp-tipped rush		✓	
Zantedeschia aethiopica	White arum lily		✓	
Elegia capensis	Horsetail restio		✓	
Typha capensis	Short bulrush (can be invasive)		✓	
Grasses				
Themeda triandra	Red grass	✓		✓
Cynodon dactylon	Kweek (can be invasive)	✓		✓
Groundcover				
Plectranthus fruticosus	Pink fly bush (shade-loving)	✓		✓
Carprobrotus spp.	Sour fig	✓		✓
Juncus lomatophyllus	Creeping rush		✓	

6. CONCLUSIONS

The two wetlands traversing Redhaus Farm have been significantly modified to a current PES of D (Largely Modified) due to damming, vegetation removal, infilling, and road construction (both on Redhaus Farm and elsewhere in the catchment).

Their Ecological Importance and Sensitivity (EIS) is classified as Very High, which along with their location in a FEPA upstream of the Whiskey Creek Nature Reserve emphasises the requirement to improve and restore the ecological structure and function as far as possible. Provided the mitigation measures in this assessment are implemented in full, it is anticipated that the PES can be improved by at least one category to a C (Moderately Modified).

Mitigation measures to restore wetland vegetation and revegetate buffers are also in the interests of the landowner as water quality in their dams will be improved and they will not silt up so rapidly, leading to reduced maintenance requirements.

The maintenance undertaken to clean out dams resulted in additional water storage along with the almost complete removal of all aquatic and littoral vegetation from Dams 2,3 and 4 using heavy machinery. This practice is detrimental for aquatic biota and severely challenges the resilience of aquatic ecosystems. Methods to mitigate the impacts of any future maintenance have been recommended in this report, along with clear instructions for the ongoing establishment and rehabilitation of riparian buffer zones and wetland areas.

Given that the Almond orchards have not yet been established on Portion 4, there is the opportunity to incorporate the full recommended buffer area excluding roads into the layout of the fields.

Redford Farm area is undergoing a general change in land use towards more intensive agriculture which is putting pressure on natural resources – both terrestrial and aquatic. In order to protect ecological structure and function, and preserve the significant biodiversity of the area, it is necessary that this transition is carefully managed, with recognised best practice applied for an optimal and sustainable balance between development and protection of the environment.

7. APPENDICES

7.1 Mapped Vegetation Type

FFs 20 Tsitsikamma Sandstone Fynbos

VT 4 Knysna Forest (58%), VT 70 False Macchia (42%) (Acocks 1953). Wet Mountain Fynbos (33%), Mesic Mountain Fynbos (21%) (Moll & Bossi 1983). LR 64 Mountain Fynbos (54%) (Low & Rebelo 1996). BHU 71 Tsitsikamma Mountain Fynbos Complex (49%), BHU 100 Knysna Afromontane Forest (19%) (Cowling et al. 1999b, Cowling & Heijnis 2001).

Distribution Western and Eastern Cape Provinces: Tsitsikamma Mountains from Uniondale to Cape St Francis, north of the Keurbooms River and south of Langkloof. Altitude 100–1 675 m (at the highest Peak Formosa).

Vegetation & Landscape Features A relatively low mountain range with gentle to steep both northern and southern slopes over 140 km, with a few high peaks and moderately undulating plains. Relatively broad compared to the other coastal mountain ranges varying from 10–20 km in width. Vegetation is a medium dense, tall proteoid shrubland over a dense moderately tall, ericoid-leaved shrubland—mainly proteoid, restioid and ericoid fynbos, with fynbos thicket in wetter areas.

Geology & Soils Acidic lithosol soils derived from Ordovician sandstones of the Table Mountain Group (Cape Supergroup), plinthic catenas prominent. Land types mainly Ib, Ca and Bb.

Climate MAP 480–1 230 mm (mean: 845 mm), fairly even throughout the year. Mean daily maximum and minimum temperatures 25.5°C and 5.8°C for February and July, respectively. Frost incidence 2–10 days per year. See also climate diagram for FFs 20 Tsitsikamma Sandstone Fynbos (Figure 4.21).

Important Taxa ([T]Cape thickets) Tall Shrubs: *Cliffortia serpyllifolia* (d), *Leucadendron conicum* (d), *L. eucalyptifolium* (d), *L. uliginosum* subsp. *glabratum*, *Leucospermum glabrum*, *Metalasia densa*, *M. trivialis*, *Mimetes pauciflorus*, *Passerina corymbosa*, *P. falcifolia*, *Protea eximia*, *P. mundii*, *P. neriifolia*, *Pterocelastrus tricuspidatus*[T]. Low Shrubs: *Erica discolor* variant '*speciosa*' (d), *E. sparsa* (d), *Ursinia scariosa* subsp. *scariosa* (d), *Agathosma ovata*, *Anisodontea scabrosa*, *Aspalathus ciliaris*, *Berzelia intermedia*, *Carpacoce vaginellata*, *Erica diaphana*, *E. glandulosa*, *E. rosacea* subsp. *rosacea*, *E. uberiflora*, *Euryops munitus*, *E. pinnatipartitus*, *Helichrysum teretifolium*, *Indigofera flabellata*, *Leucadendron salignum*, *L. spissifolium* subsp. *phillipsii*, *Leucospermum cuneiforme*, *Metalasia pulcherrima* f. *pallescens*, *Otholobium carneum*, *Passerina pendula*, *Penaea cneorum* subsp. *gigantea*, *Phylica axillaris*, *P. imberbis*, *Protea cynaroides*, *Stoebe plumosa*. Herbs: *Commelina africana*, *Gazania krebsiana* subsp. *krebsiana*. Geophytic Herbs: *Geissorhiza fourcadei*, *G. inconspicua*, *Romulea pratensis*. Graminoids: *Restio triticeus* (d), *Tetraria capillacea* (d), *Diheteropogon filifolius*, *Elegia juncea*, *Epischoenus adnatus*, *Heteropogon contortus*, *Hypodiscus synchroolepis*, *Tetraria robusta*, *Thamnochortus fruticosus*, *T. glaber*, *Themeda triandra*, *Tristachya leucothrix*.

Endemic Taxa Low Shrubs: *Aspalathus teres* subsp. *thodei*, *Erica trachysantha*, *E. zitzikammensis*, *Felicia tsitsikamae*, *Helichrysum outeniquense*.

Conservation Vulnerable. Target 23%. Statutorily conserved (about 40%) in the proposed Garden Route National Park (including Tsitsikamma and Soetkraal). Some 33% transformed (cultivation, pine plantations). With scattered alien *Pinus pinaster* and *Hakea sericea*. Erosion very low.

Remark 1 Wetter habitats, especially in berg wind shadows east of dissected valleys, support afrotemperate forests. Most of the bigger patches of the forest are positioned on and around the shales of the Gydo Formation.

Remark 2 The coastal strip contains a narrow shoreward band of dune fynbos communities that were not mapped, but included within this unit.

References Bond (1978a), Cowling (1984), Bond et al. (1988), Hanekom et al. (1989).

7.2 Wetland PES Assessment Method

The Present Ecological State (PES) of wetlands on Redhaus Farm were assessed using the Level 1 WET-Health assessment tool developed by Macfarlane *et al*. (2008). The tool aims to assess the integrity of a wetland which is defined as a measure of the deviation of wetland structure and function from the wetland's natural reference condition. The method combines an assessment of hydrological, geomorphological and vegetation health in three modules.

Data collection involved a desktop review of the extent and intensity of catchment land use impacts and was undertaken using historical and recent aerial imagery of the site (Chief

Directorate: National Geo-spatial Information and satellites). Fieldwork onsite involved the identification and recording of observable impacts to the wetland at the site of relevant activities as well as at reference points upstream and downstream of the activities. The magnitude of observed impacts to the hydrological, geomorphological and vegetation components of the wetland were calculated and combined as per the tool to provide a measure of the overall wetland condition of the wetland. The condition ranges in scale from 1-10 and resultant scores were then used to assign the wetland into one of six PES categories as shown in Table 14.

Table 14.Wetland Present Ecological State (PES) categories and impact descriptions.

Ecological Category	Description	Impact Score
A	Unmodified, natural.	0 – 0.9
B	Largely natural with few modifications / in good health. A small change in natural habitats and biota may have taken place but the ecosystem functions are still predominantly unchanged.	1 – 1.9
C	Moderately modified / fair condition. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	2 – 3.9
D	Largely modified / poor condition. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	4 – 5.9
E	Seriously modified / very poor condition. The loss of natural habitat, biota and basic ecosystem functions is extensive.	6 – 7.9
F	Critically modified / totally transformed. Modifications have reached a critical level and the lotic system has been modified completely with an almost complete loss of natural habitat and biota.	8 - 10

7.3 Wetland EIS Assessment Method

The revised method for the determination of the EIS of a wetland considers the three following ecological aspects (Rountree *et al.*, 2013):

- **Ecological importance and sensitivity**
  - Biodiversity support including rare species and feeding/breeding/migration;
  - Protection status, size and rarity in the landscape context;
  - Sensitivity of the wetland to floods, droughts and water quality fluctuations.
- **Hydro-functional importance**
  - Flood attenuation;
  - Streamflow regulation;
  - Water quality enhance through sediment trapping and nutrient assimilation;
  - Carbon storage
- **Direct human benefits**
  - Water for human use and harvestable resources;
  - Cultivated foods;
  - Cultural heritage;
  - Tourism, recreation, education and research.

Each criterion is scored between 0 and 4, and the average of each subset of scores is used to derive a score for each of the three components listed above. The highest score is used to determine the overall Importance and Sensitivity category of the wetland system (Table 15).

Table 15.Ecological importance and sensitivity categories for wetlands. Interpretation of average scores for biotic and habitat determinants.

Ecological Importance and Sensitivity Category (EIS)	Range of Median	Recommended Ecological Management Class
Very high: Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these floodplains is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and <=4	A
High: Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these floodplains may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and <=3	B
Moderate: Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these floodplains is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and <=2	C
Low/marginal: Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these floodplains is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and <=1	D

7.4 Impact Assessment Methods

Criteria are ascribed for each predicted impact. These include the intensity (size or degree scale), which also includes the type of impact, being either a positive or negative impact; the duration (temporal scale); and the extent (spatial scale), as well as the probability (likelihood). The methodology is quantitative, whereby professional judgement is used to identify a rating for each criterion based on a seven-point scale (Table 16) and the significance is auto-generated using a spreadsheet through application of the calculations.

For each predicted impact, certain criteria are applied to establish the likely **significance** of the impact, firstly in the case of no mitigation being applied and then with the most effective mitigation measure(s) in place.

These criteria include the **intensity** *(*size or degree scale), which also includes the **nature** of impact, being either a positive or negative impact; the **duration** (temporal scale); and the **extent** (spatial scale). These numerical ratings are used in an equation whereby the **consequence** of the impact can be calculated. Consequence is calculated as follows:

Consequence = type x (intensity + duration + extent)

To calculate the significance of an impact, the **probability** (or likelihood) of that impact occurring is applied to the consequence.

Significance = consequence x probability

Depending on the numerical result, the impact would fall into a significance category as negligible, minor, moderate or major, and the type would be either positive or negative.

Table 16. Assessment criteria for the evaluation of impacts

Criteria	Numeric Rating	Category	Description
Duration	**1**	**Immediate**	Impact will self-remedy immediately
	2	**Brief**	Impact will not last longer than 1 year
	3	**Short term**	Impact will last between 1 and 5 years
	4	**Medium term**	Impact will last between 5 and 10 years
	5	**Long term**	Impact will last between 10 and 15 years
	6	**On-going**	Impact will last between 15 and 20 years
	7	**Permanent**	Impact may be permanent, or in excess of 20 years
Extent	**1**	**Very limited**	Limited to specific isolated parts of the site
	2	**Limited**	Limited to the site and its immediate surroundings
	3	**Local**	Extending across the site and to nearby settlements
	4	**Municipal area**	Impacts felt at a municipal level
	5	**Regional**	Impacts felt at a regional level
	6	**National**	Impacts felt at a national level
	7	**International**	Impacts felt at an international level
Intensity	**1**	**Negligible**	Natural and/ or social functions and/ or processes are negligibly altered
	2	**Very low**	Natural and/ or social functions and/ or processes are slightly altered
	3	**Low**	Natural and/ or social functions and/ or processes are somewhat altered
	4	**Moderate**	Natural and/ or social functions and/ or processes are moderately altered
	5	**High**	Natural and/ or social functions and/ or processes are notably altered
	6	**Very high**	Natural and/ or social functions and/ or processes are majorly altered
	7	**Extremely high**	Natural and/ or social functions and/ or processes are severely altered
Probability	**1**	**Highly unlikely / None**	Expected never to happen
	2	**Rare / improbable**	Conceivable, but only in extreme circumstances, and/or might occur for this project although this has rarely been known to result elsewhere
	3	**Unlikely**	Has not happened yet but could happen once in the lifetime of the project, therefore there is a possibility that the impact will occur
	4	**Probable**	Has occurred here or elsewhere and could therefore occur
	5	**Likely**	The impact may occur
	6	**Almost certain / Highly probable**	It is most likely that the impact will occur
	7	**Certain / Definite**	There are sound scientific reasons to expect that the impact will definitely occur

When assessing impacts, broader considerations are also considered. These include the level of confidence in the assessment rating; the reversibility of the impact; and the irreplaceability of the resource as set out in (Table 17, Table 18, and Table 19), respectively.

Table 17. Definition of confidence ratings.

Category	Description
Low	Judgement is based on intuition
Medium	Determination is based on common sense and general knowledge
High	Substantive supportive data exists to verify the assessment

Table 18. Definition of reversibility ratings.

Category	Description
Low	The affected environment will not be able to recover from the impact - permanently modified
Medium	The affected environment will only recover from the impact with significant intervention
High	The affected environmental will be able to recover from the impact

Table 19. Definition of irreplaceability ratings.

Category	Description
Low	The resource is not damaged irreparably or is not scarce
Medium	The resource is damaged irreparably but is represented elsewhere

8. REFERENCES

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