CONSRUCTION OF TENTED CAMPS ADJACENT TO A DAM ON THE REMAINDER OF FARM NO. 432, KRANSHOEK, CAIRNBROGIE, PLETTENBERG BAY

Section 21 c & i Risk Assessment

Prepared for Hilland Environmental

by

Confluent Environmental

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Date: 11 December 2018

EXECUTIVE SUMMARY

The landowners of the Remainder of Farm no. 432, Kranshoek, Cairnbrogie, Plettenberg Bay plan to construct tented camps adjacent to a dam located on the property.

This report serves to provide the landowners with a risk assessment for activities associated with the construction of the tents to assess whether these activities require a water use license or not. The DWS Risk Assessment Protocol was applied to all activities related to the construction and operation of the tented camps to establish whether the risk posed by these activities to water resource quality (i.e. flow regime, water quality, habitat and biota is low, medium or high) warrants a water use license. High and medium ranking risks may trigger the need for a water use licence, while low risks require that the proponent must comply with the General Authorisations pertaining to Section 21(c) and (i) water uses (Government Notice 509 of 2016).

The construction of tents will take place on the shores of a small dam located on the property which is located within quaternary catchment K60G and the sub-quaternary reach is not recognised as a National Freshwater Ecosystem Priority Area (NFEPA). The tents are proposed to be located above the full supply level of the existing dam and therefore falls outside of the area of inundation. The tents will be positioned on raised wooden decks which will be located between a row of planted yellowwood trees that lines the banks of the dam. The tents and boardwalk will therefore be located primarily within terrestrial habitat although some disturbance of wetland plant species is expected during construction activities.

The Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of the watercourse was determined to be Largely Modified (D) and Moderate (C), respectively. Risk ratings (as determined by the DWS Risk Assessment Matrix) for all activities in both the construction and operational phase are low and minimal disturbance to flow, aquatic habitat, water quality and biota is expected. Most importantly the PES and EIS of the dam and the larger river reach is not expected to deteriorate beyond its current state. The confidence associated with this assessment is very high.

Given the low risk ratings as determined by the DWS Risk Assessment Matrix and according to GN 509 of August 2016, the proposed activities are generally authorised and a water use license is therefore not required.

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Construction activities can potentially impede or alter the flow of water in the watercourse, which may trigger a Section 21(c) water use, as defined in terms of the provisions of the National Water Act, Act 36 of 1998) (NWA) (South Africa, 1998). Construction activities can also potentially alter the bed, banks, course or characteristics of a watercourse, which may trigger a Section 21(i) water use. In terms of the NWA, a dam is defined as part of a watercourse and therefore in this report, the word dam and watercourse are used referred to as watercourses.

This report serves to provide the landowners with a risk assessment for activities associated with the construction of the tents to assess whether these activities require a water use license or not. The DWS Risk Assessment Protocol was applied to all activities related to the construction and operation of the tented camps to establish whether the risk posed by these activities to water resource quality (i.e. flow regime, water quality, habitat and biota is low, medium or high) warrants a water use license. High and medium ranking risks may trigger the need for a water use licence, while low risks require that the proponent must comply with the General Authorisations pertaining to Section 21(c) and (i) water uses (RSA, 2016).

1.1 Scope of Work

The scope of work for this project included the following:

- Conduct a site visit with a view to assessing the Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of the watercourse;
- Determine the need for water use licensing through Assess the potential impacts of the construction and operational phase activities on the watercourse through

2. STUDY AREA

The construction of tents will take place on the shores of a small dam located on the remaining portion of Remainder of Farm no. 432, Kranshoek, Cairnbrogie, Plettenberg Bay. The farm is located within quaternary catchment K60G and the sub-quaternary reach is not recognised as a Freshwater Ecosystem Priority Area (Figure 1). The study area is within ecoregion 20.02, the South Eastern Coastal Belt. Typical terrain is moderate to high relief, with undulating plains and low mountains. Altitude ranges from 0 – 1 300 m.a.m.s.l. The vegetation type is classified broadly as Garden Route Shale Fynbos (Mucina and Rutherford, 2006) which is endangered.

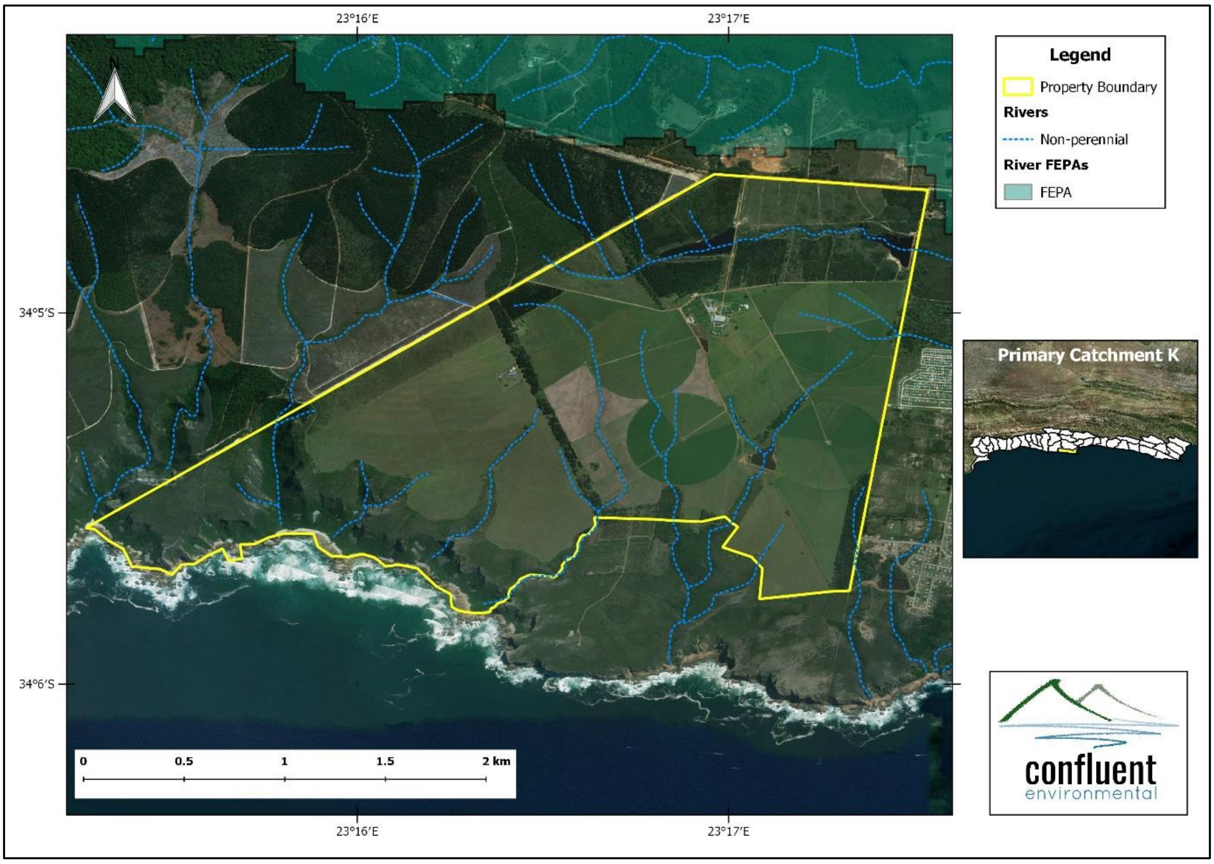

Figure 1: Location of the Remainder of Farm no. 432, Kranshoek, Cairnbrogie, Plettenberg Bay

3. SPATIAL BIODIVERSITY AND CONSERVATION PLANNING

3.1 National Freshwater Ecosystem Priority Areas (NFEPA)

The watercourse does not fall within a NFEPA sub-quaternary reach and has therefore not been prioritised for the conservation of freshwater ecosystems and associated biodiversity.

3.2 Western Cape Biodiversity Spatial Plan (WCBSP)

The affected section of the watercourse falls within a category 2 Ecological Support Area (ESA 2) (Figure 2). These are designated as areas that are not essential for meeting biodiversity targets, but that play an important role in supporting the functioning of Protected Areas (PAs) or Critical Biodiversity Areas (CBAs), and are often vital for delivering ecosystem services. The management objective for such areas is to 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.

The adjacent terrestrial area falls within and ESA1. These areas are of equal importance to ESA2 areas but have different management objectives which require maintenance of a functional, near-natural state. Some habitat loss is acceptable, provided the underlying biodiversity objectives and ecological functioning are not compromised.

Figure 2: Location of proposed tented camp in relation to the Western Cape Biodiversity Spatial Plan (WCBSP).

4. SITE DESCRIPTION

The PES and EIS of the watercourse was assessed using recognised methods, the details of which can be viewed in the Appendix to this report.

The tented camps will be located along the shore of a dam that has been built in a perennial drainage line that flows from east to west (Figure 3). The dam receives runoff from several small drainage lines in the surrounding catchment. Predominantly terrestrial vegetation lines the banks of the dam, although the wetland dependent species *Pennisetum macrourum* is also relatively abundant (Figure 4). Several wetland plant species occur on the outer edges of the shoreline and into the shallow littoral zone of the dam. These include the bulrush *Typha capensis*, the sedges *Eleocharis limosa*, *Fuirena hirsuta* and *Pycreus polystachyos* and *Zantedeschia aethiopica* (Arum lily).

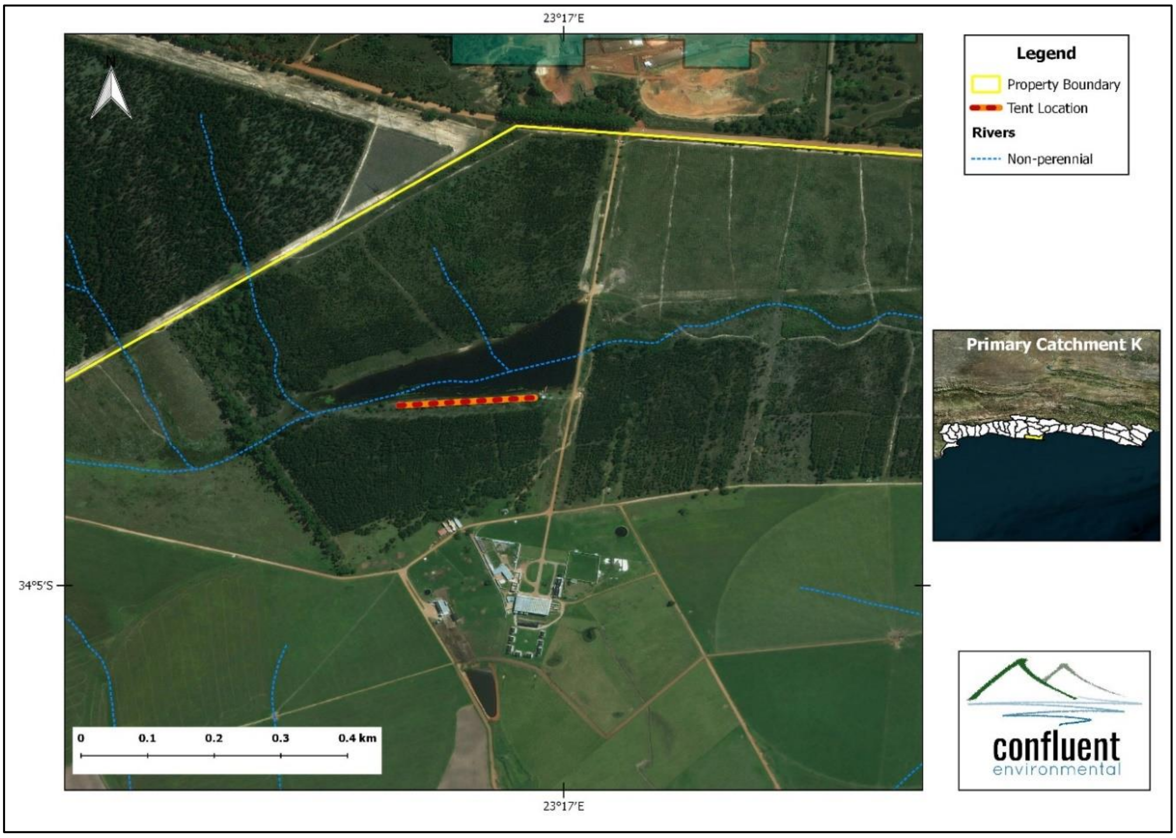

Figure 3: Approximate location of tents in relation to the dam located on the remainder of Farm no. 432, Kranshoek, Cairnbrogie, Plettenberg Bay

Figure 4: Selection of photographs from the site indicating dense stands of Pennisetum macrourum along the banks (A); wetland vegetation consisting mainly of Cyperus sp. in the shallow littoral zone (B); the dam wall (C) and a view of the dam upstream from the dam wall.

4.1 Present Ecological State

The PES of the section of drainage line is Largely Modified (Table 1). This is primarily related to the presence of two farm dams in the drainage line which have significantly modified the flow and geomorphological characteristics of the watercourse along this reach. The surrounding catchment area is dominated by forestry plantations and alien invasive trees although some clearing adjacent to northern and southern bank of the dam has recently been undertaken.

Table 1: Instream and riparian IHI scores for the watercourse.

In-stream Habitat		Riparian Habitat	
Water abstraction	**6** – Abstraction from farm dams	**Vegetation removal**	**8** – Riparian buffer absent along banks of dam
Flow modification	**20** – Farm dams located within the stream affect flow and flood volumes.	**Invasive vegetation**	**18** – High levels of invasive vegetation throughout the catchment area
Bed modification	**11** – Downstream sediment transport reduced due to dam.	**Bank erosion**	**5** - Minor
Channel modification	**11** – Incised channel due to sediment starvation and bank erosion	**Channel modification**	**10** – Incised channel largely cuts the river off from the adjacent riparian zone.
Physico-chemistry	**8 –** Evidence of nutrient and high turbidity water	**Water abstraction**	**10** – Presence of alien invasive vegetation likely to significantly increase abstraction
Inundation	**14 –** Inundation of stretches of aquatic habitat due to the presence of farm dams.	**Inundation**	**10** – Inundation of stretches of riparian habitat due to the presence of farm dams.
Alien macrophytes	**0 –** None observed	**Flow modification**	**10** –Reduced water availability in the riparian zone due to farm dams and presence of high water use alien invasive trees.
Alien aquatic fauna	**8 –** None recorded, although alien fish species are known to occur in farm dams throughout the catchment	**Physico-chemistry**	**0** – None
Rubbish dumping	**0 –** None		
IHI score	**50 (D)**		**51 (D)**
PES	**D (Largely Modified)**		

4.2 Ecological Importance and Sensitivity

The EIS of the watercourse is Moderate (Table 2). The relatively low rating of the watercourse is primarily due to the fact that it is a non-perennial drainage line and is therefore less sensitive to changes in flow and water quality and provides limited refuge and migration support to aquatic species. Given its ephemeral nature, few species are expected to be intolerant to changes in flow conditions. From a conservation planning perspective, the watercourse does not fall within a FEPA and is regarded as an ESA.

Table 2: Ecological Importance and Sensitivity (EIS) scores for the watercourse

Determinant	Northern Tributary
Presence of Rare & Endangered Species	**0** - No rare or endangered species/taxon at any scale
Populations of Unique Species	**2 -** One population (or taxon) judged to be unique at a local scale.
Intolerant Biota	**1** - A small proportion of the biota is expected to be dependent on flowing water for the completion of their life cycle.
Species/Taxon Richness	**2** - Moderate diversity of fauna and flora expected on a local scale.
Diversity of Habitat Types or Features	**2** - Moderate diversity of aquatic habitats. Important at a local scale.
Refuge value of habitat types	**3** – Non-perennial watercourse provides important refuge habitats for a wide range of terrestrial and aquatic biota
Sensitivity of habitat to flow changes	**2** – A non-perennial stream which is likely to be moderately sensitive to changes in flow
Sensitivity to flow related water quality changes	**2** – A non-perennial stream which is unlikely to be sensitive modifications in water quality.
Migration route for instream and riparian biota	**2** - The stream delineation is a moderately important link in terms of connectivity for the survival of biota upstream and downstream and is moderately sensitive to modification.
Protection Status	**1** – The watercourse falls within an Ecological Support Area and is considered moderately important for meeting biodiversity targets for ecosystems, species and ecological processes at a provincial level. The sub-quaternary reach does not fall within a FEPA
EIS Score	**2 (Moderate Importance and Sensitivity)**

5. DESCRIPTION OF ACTIVITIES

The tents are proposed to be located above the full supply level of the existing dam and therefore falls outside of the area of inundation. The tents will be positioned on raised wooden decks which will be located between a row of planted yellowwood trees that lines the banks of the dam (Figure 5). The tents and boardwalk will therefore be located primarily within terrestrial habitat. The main wetland plant species occurring in the area in which the boardwalk and tents will be constructed is *P. macrourum*. This is an indigenous grass species that generally grows adjacent to watercourses and is also referred to as Riverbed Grass (van Ginkel et al., 2011).

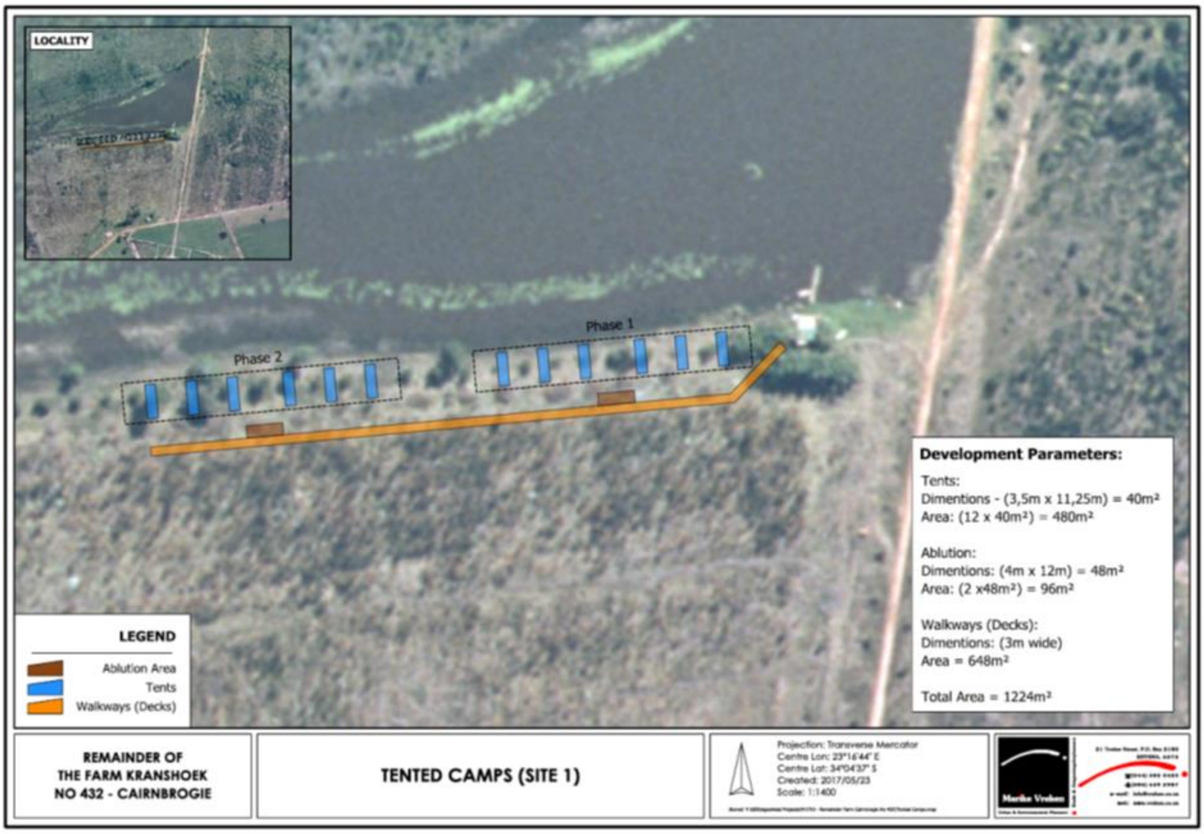

Figure 5: Proposed layout of tented camps

5.1 Construction Phase

Construction phase activities involve the installation of wooden poles just inland of the shoreline of the dam to support the deck. This could potentially result in the localised disturbance and mobilisation of soil and sediment into the dam. The profile of the bank of the dam is relatively flat and well vegetated and erosion is therefore unlikely to occur. Wetland plant species are expected to be minimally impacted, as the majority of species are located within the full supply level of the dam, in the shallow littoral zone. While some loss of wetland plants may occur above the full supply level, the scale of loss is not anticipated to significantly impact on the existing aquatic habitat. The boardwalk will be set back from the shoreline and littoral zone and gaps will be present between each tent (Figure 5).

5.1.1 Mitigation measures

- Construction will take place above the full supply level of the dam and infrastructure will be located in predominantly terrestrial vegetation as opposed to wetland vegetation;
- Use of raised wooden decks reduces the impact to aquatic habitat to the minimum;
- The relatively flat profile of the construction area will minimise erosion towards the dam;
- Construction operations will be done from the plantation area building the supports and then the decks and then all work takes place on the decks.

5.2 Operational Phase

The tourism facility will have guests visiting and living in close proximity to the water and the surrounding vegetation. The raised wooden deck will allow for the re-establishment of any wetland vegetation that had been disturbed during the construction phase. The raised decks will also facilitate connectivity between the terrestrial and aquatic environment and are also likely to provide refuge and cover for a wide range of aquatic associated and terrestrial biota.

5.2.1 Mitigation measures

- Visitors will be directed by signage and all pedestrian traffic will be on boardwalks above the vegetation to limit any effect of trampling and disturbance of aquatic habitat;
- The parking and other services are located behind the tents away from the water;
- All access to the water will be from the existing small boat house located at the dam;
- Raised decks will allow any disturbed vegetation to recover over time.

6. WATER USE LICENSE & RISK ASSESSMENT

The DWS Risk Assessment Matrix was used to assess the risk of the proposed activities to the watercourse. A comprehensive description of the matrix can be viewed in the Appendix to this report.

The planned tented camp is located outside of the full supply level of the dam and will therefore not impede or divert flow of water in the watercourse. The placement of wooden support poles will also not impede or divert the flow of water running into the dam. As such a Section 21 c water use is not applicable and only a Section 21 i water use is of relevance here.

In this respect risk ratings for all activities in both the construction and operational phase are low and minimal disturbance to flow, aquatic habitat, water quality and biota is expected (Table 3 and Table 4). Most importantly the PES and EIS of the dam and the larger river reach is not expected to deteriorate beyond its current state. The confidence associated with this assessment is very high.

Table 3: Construction phase risk matrix completed by Dr. James Dabrowski (SACNASP registration number 114084). Severity scores assume full implementation of mitigation measures)

				Severity																	
Phases	**Activity**	**Aspect**	**Impact**	**Flow Regime**	**Water Quality**	**Habitat**	**Biota**	**Severity**	**Spatial scale**	**Duration**	**Consequence**	**Frequency of activity**	**Frequency of impact**	**Legal Issues**	**Detection**	**Likelihood**	**Significance**	**Risk Rating**	**Confidence level**	**Control Measures**	**PES AND EIS OF WATERCOURSE**
Construction Phase	Installation of support poles	Disturbance of soil	• Soil erosion • Increased turbidity • Sedimentation of wetland habitat	**1**	**2**	**2**	**1**	**2**	**1**	**1**	**4**	**1**	**1**	**5**	**2**	**9**	**33**	**Low**	**90**	• Construction will take place outside of the full supply level of the dam • Use of raised wooden decks reduces the impact to the minimum	PES: D EIS: Moderate
		Loss of vegetation	• Loss of wetland habitat • Reduced connectivity	**1**	**2**	**2**	**1**	**2**	**1**	**1**	**4**	**1**	**3**	**5**	**1**	**10**	**37**	**Low**	**90**		

Table 4: Operational phase risk matrix completed by Dr. James Dabrowski (SACNASP registration number 114084). Severity scores assume full implementation of mitigation measures)

Phases	Activity	Aspect	Impact	Severity: Flow Regime	Severity: Water Quality	Severity: Habitat	Severity: Biota		Severity	Spatial scale	Duration		Consequence		Frequency of activity	Frequency of impact	Legal Issues	Detection		Likelihood	Significance	Risk Rating	Confidence level	Control Measures	PES AND EIS OF WATERCOURSE
Operational Phase	Guests visiting and living in close proximity to the water	Disturbance to wetland vegetation	• Loss of wetland habitat and biota	1	1	2	2		2	1	1		4		4	1	5	2		12	42	Low	90	• Visitors will be directed by signage and all pedestrian traffic will be on boardwalks above the vegetation to limit any effect of trampling • The parking and other services are located behind the tents away from the water • All access to the water will be from the existing small boat house located at the dam • Raised decks will allow any disturbed vegetation to recover over time.	PES: D EIS: Moderate

7. CONCLUSION

Given the Low risk ratings as determined by the DWS Risk Assessment Matrix and according to GN 509 of August 2016, the proposed activities are generally authorised and a water use license is not required.

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APPENDIX

8. METHODS

8.1.1 Present Ecological State

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

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 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**

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

8.1.2 Ecological Importance and Sensitivity

The ecological importance of a river 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 ecological importance and sensitivity (EIS) of the northern and southern tributaries were 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 wetland;
  - 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 wetland:**
  - Sensitivity of wetland to changes in flooding regime;
  - Sensitivity of wetland 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: Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands 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 wetlands 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 wetlands 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 wetlands 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**

8.1.3 DWS Risk Assessment

The risk assessment matrix (Based on DWS 2015 publication: Section 21 c and i water use Risk Assessment Protocol) was implemented to assess risks for each activity associated with the construction and operational phase.

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

- An activity is a distinct process or task undertaken by an organisation for which a responsibility can be assigned. Activities also include facilities or infrastructure that is possessed by an organisation.
- An aspect is an 'element of an organizations activities, products and services which can interact with the environment'. The interaction of an aspect with the environment may result in an impact.
- Environmental impacts are the consequences of these aspects on environmental resources or receptors of particular value or sensitivity.
- Resources are components of the biophysical environment and include the flow regime, water quality, habitat and biota of the affected watercourse.
- Severity refers to the degree of change to the status of each of the receptors (Table 9). An overall severity score is calculated as the average of all scores receptor status in terms of the reversibility of the impact; sensitivity of receptor to stressor; duration of impact (increasing or decreasing with time); controversy potential and precedent setting; threat to environmental and health standards.
- Spatial extent refers to the geographical scale of the impact (Table 10).
- Duration refers to the length of time over which the stressor will cause a change in the resource or receptor (Table 11)

- Frequency of activity refers to how often the proposed activity will take place (Table 12).
- Frequency of impact refers to the frequency with which a stressor (aspect) will impact on the resource (Table 13).

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

In accordance with the method stipulated in the risk assessment key, all impacts for flow regime, water quality, habitat and biota were scored as a 5 (i.e. average Severity score of 5) as all activities will occur within the delineated boundary of the wetland.

Table 9: Scores used to rate the impact of the aspect on resource quality (flow regime, water quality, geomorphology, biota and habitat)

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

Table 10: Scores used to rate the spatial scale that the aspect is impacting on.

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

Table 11: Scores used to rate the duration of the aspects impact on resource quality

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

Table 12: Scores used to rate the frequency of the activity

Annually or less	1
Bi-annually	2
Monthly	3
Weekly	4
Daily	5

Table 13: Scores used to rate the frequency of the activity's impact on resource quality

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

Table 14: Scores used to rate the extent to which the activity is governed by legislation

No legislation	1
Fully covered by legislation (wetlands are legally governed)	5

Table 15: Scores used to rate the ability to identify and react to impacts of the activity on resource quality, people and property.

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

Table 16: Rating classes

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

Table 17: Calculations used to determine the risk of the activity to water resource quality

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

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TERTIARY EDUCATION

2002–2004 **Ph.D.: Freshwater Research Unit, Department of Zoology, University of Cape Town**
"A comparison of runoff and spray drift related pesticide contamination in agricultural surface waters: exposure, effects and mitigation."
Supervisors: Prof J.A. Day and Prof. R. Schulz

2000–2001 **M.Sc. (Cum Laude): Department of Zoology, University of Stellenbosch**
"Prediction and ecotoxicological effects of runoff induced pesticide contamination in agricultural surface waters: A risk assessment using GIS and microcosms."
Supervisors: Prof A.J. Reinecke and Prof. R. Schulz

1999 **B.Sc. Honours: Department of Zoology, University of Stellenbosch**
Supervisors: Prof A.J. Reinecke, Prof. R. Schulz

1996-1998 **B.Sc. in Zoology and Botany, University of Stellenbosch**

EMPLOYMENT RECORD

Present **Confluent Environmental - Co-Director:** Provision of aquatic consulting and research services to the agricultural, industrial, mining, tourism and private sectors in South Africa and the rest of Africa including conducting specialist studies for environmental assessments as required by national and international legislation (e.g. National Water Act of 1998, National Environmental Management Act of 1998).

2006-2017 **CSIR (Natural Resources and Environment) – Principal Researcher:** Responsible for attracting funding and conducting research in the field of water quality and environmental chemistry, catchment modelling, water footprinting and aquatic ecotoxicology within the Water Ecosystems Research Group.

2004-2006 **Department of Water Affairs and Forestry - Specialist Scientist:** Responsible for the development of procedures to assess toxicological quality and aquatic ecosystem integrity, provide scientific and technical advice on water resource quality management and development, design and implementation of the National Toxicity Monitoring Programme (NTMP), derivation of water quality guidelines for toxicants in support of the NTMP and training and capacity building of junior staff and scientists.

2002-2004 **University of Cape Town - Scientific Officer**. PhD research work on the occurrence, mitigation and risk assessment of pesticides in the Lourens River, Western Cape, South Africa. Supervision of Honours and Masters students and lecturing in aquatic ecotoxicology and aquatic biogeochemical cycling.

KEY EXPERTISE

- Aquatic Ecology
- Water Quality
- Ecotoxicology
- Ecological Risk Assessment
- Geographical Information Systems
- Field & Catchment Scale Water Quality Modelling

RELEVANT PROJECT EXPERIENCE

- **An integrated approach to managing and mitigating the risk of agricultural nonpoint source pesticide pollution to the aquatic environment** *(Project Leader)* Develop monitoring, modelling and risk assessment approaches to identify specific management and farming practices aimed at reducing the impact of waterborne agricultural chemicals on water resources. *Client: Water Research Commission (2017-2022).*
- **Incorporating environmental fate models into risk assessment for pesticide registration in South Africa** *(Project Leader)* Development of an improved aquatic risk assessment framework that integrates exposure and hazard for the purpose of registering pesticides for agricultural use in South Africa. Client: *Water Research Commission (2016-2019)*.
- **Development of ecological risk assessment tools for protection of ecosystem health:** *(Project Leader)* Development and application of risk indicators, passive samplers and catchment modelling approaches to protect aquatic ecosystem health form agrochemical use, with a case study on the endangered Twee River Redfin (*Barbus erubescens*). *Client: CSIR (2015-2017).*
- **Quantifying and managing agricultural non-point source (NPS) nutrient pollution from field to catchment scale** *(Principal Researcher)* Responsible for application of the SWAT model in the middle Olifants catchment and student supervision. *Client: Water Research Commission (2015-2018).*
- **Developing a siltation strategy for the purpose of assisting dam basin management** *(Principal Researcher) Client: Department of Water and Sanitation (2016-2017).*
- **Revision of the 1996 South African Water Quality Guidelines: Development of risk-based approach using irrigation water use as a case study** *(Team Member).* Responsible for development of irrigation guidelines for herbicides. *Client: Water Research Commission (2014-2016).*
- **Investigation of the contamination of water resources by agricultural chemicals and the impact on environmental health** (*Project Leader)* Risk assessment of agro-chemicals (including fertilizers and pesticides) on human and environmental health, including prioritizing pesticides for human health effects and development of pesticide use maps. *Client: Water Research Commission (2010-2015).*
- **AquaBASE: Understanding and managing freshwater ecosystems in South Africa.** *(Project Leader).* Modelling the network of relationships between freshwater management options, ecological features and biophysical processes to produce "ecological production functions" that allow for the quantification of ecosystem services needed to restore water quality in the Upper Olifants River catchment of South Africa. *Client: CSIR (2012-2014).*
- **Linking land use to water quality for effective water resource and ecosystem management** *(Project Leader)* Development of a decision support system aimed at facilitating decisions on how

changes on land use impact on water quality and aquatic ecosystem health. *Client: Water Research Commission (2010-2013).*

- **Land use practices that sustain water resources: Eutrophication** *(Principal Researcher)* Identification and testing of highly feasible solutions that will restore water resource quality with respect to eutrophication. *Client: CSIR (2010-2012).*
- **An overview of water quality and the causes of poor water quality in the Olifants River catchment, South Africa** (*Senior Researcher)*. Analysis of water quality data and development of maps. *Client: Water Research Commission (2010-2011).*
- **Upper Olifants Risk Assessment** *(Senior Researcher)* Risk assessment of pollution associated with coal mining, agriculture and sewage in surface waters of the upper Olifants River system: Implications for aquatic ecosystem health and the health of human users of water. Included application of SWAT model to estimate spatial and temporal sources of nutrient pollution leading to eutrophication | *Client: Coaltech (2009-2013).*
- **Development of a risk indicator methodology to estimate the relative risk of pesticide contamination in South African water resources.** (*Project Leader*): Predicting the relative impacts of pesticides on the aquatic environment through the integration of application, toxicity and physicochemical data of pesticides, together with site-specific geographic and climatic characteristics. *Client: Water Research Commission* (2008-2009).
- **Waterberg Aquatic Baseline Study** (*Senior Researcher*): Characterisation of the Waterberg aquatic ecosystem and development of water quality indicators in anticipation of future coal mining developments in the region. *Client: ESKOM (2008-2009).*
- **Water and Agriculture for Food Security** (*Project Leader and Senior Researcher*). Investigation of the impact of agriculture on water use and water quality, with emphasis on virtual water trading, integrated water resource management and food security in the Southern African context. *Client: CSIR (2006-2008).*
- **Water Quality Monitoring Data and Target Users: Maximising Value** (*Senior Researcher*) Recommendations for optimal information transfer mechanisms to realise the full value of water quality monitoring in a number of scenarios relevant to Southern Africa. *Client: Water Research Commission (2007-2008).*
- **South African Mercury Assessment Programme** (*Senior Researcher*): Assessment of mercury in South African water resources and the compilation of an inventory detailing mercury emissions from coal-fired power stations in South Africa. *Client: CSIR (2006-2008).*
- **National Toxicity Monitoring Programme** (*Specialist Scientist*). Development of a national monitoring programme and aquatic ecosystem and human health water quality guidelines for organic pollutants in support of the National Toxicity Monitoring Programme. *Client: Department of Water Affairs and Forestry (2006-2008).*
- **ENVIROMAP** *(PhD researcher*): Risk assessment (including fate, exposure, ecotoxicological effects and mitigation) of pesticides in non-target water environments in agricultural areas of the Western Cape, South Africa. *Client: Volkswagen Stiftung, Hannover, Germany (2002-2004).*

RELEVANT CONSULTING EXPERIENCE

- **Olifants Water Resources Development Project** (*Senior Researcher*): Development of a monitoring and reporting system. *Client: ACER (2008).*
- Mokolo-Crocodile Water Augmentation Project (Principal Researcher): Report on the potential effects of scour valve discharge on water quality in the Matlabas River. *Client: TCTA (2016).*

PROFESSIONAL ASSOCIATIONS & OTHER QUALIFICATIONS

Research Affiliations

- Research Associate (Sustainability Research Unit, Nelson Mandela Metropolitan University)
- Associate (Freshwater Research Centre)

Professional Societies

- Society for Environmental Toxicology and Chemistry (SETAC)
- International Water Association (IWA)
- South African Council for Natural Scientific Professionals (SACNASP)

Scientific Review

- Associate editor (Bulletin for Environmental Toxicology and Chemistry)
- Proposal review (Water Research Commission and National Research Foundation)
- Reference Group member (various Water Research Commission projects)

SCIENTIFIC PUBLICATIONS

Petersen, F., **Dabrowski, J.M.**, and Forbes, P.B.C. (2017). Identifying potential surface water sampling sites for emerging chemical pollutants in Gauteng Province, South Africa. *Water SA*, 43(1), 153-165.

Dabrowski, J., Baldwin, D.S., **Dabrowski, J.M.,** Hill, L., and Shadung, J. (2017). Impact of temporary desiccation on the mobility of nutrients and metals from sediments of Loskop Reservoir, Olifants River. *Water SA*, 43(1), 7-16.

Stehle, S, **Dabrowski, J.M.,** Bangert U. and Schulz R. (2016). Erosion rills offset the efficacy of vegetated buffer strips to mitigate pesticide exposure in surface waters. *Science of the Total Environment.* 545-546: 171-183.

Nsibande, S.A., **Dabrowski, J.M.**, van der Walt, E., Venter, A. and Forbes, P.B.C. (2015). Validation of the AGDISP model for predicting airborne atrazine spray drift: A South African ground application case study. *Chemosphere* 138: 454-461.

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Schulz, R., Thiere, G., and **Dabrowski, J.M.** (2002) A combined microcosm and field approach to evaluate the aquatic toxicity of azinphos-methyl to stream communities. *Environmental Toxicology and Chemistry*. 21 (10): 2172-2178

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Schulz, R., Peall, S.K.C., **Dabrowski, J.M.** and Reinecke, A.J. (2001) Current-use insecticides, phosphates and suspended solids in the Lourens River, Western Cape, during the first rainfall event of the wet season. *Water SA*. 27: 65-70.