



RIPARIAN ASSESSMENT

DESERT STAR PIGGERIES

BOTRIVIER IN THE WESTERN CAPE PROVINCE

MAY 2018



Oasis Environmental Specialists (Pty) Ltd

Tel: 016 987 5033

Cell: 076 589 2250

Email: joppie@oasisenvironmental.co.za

Website: <http://oasisenvironmental.co.za>

37 Oorbietjies Street, Lindequesdrift

Potchefstroom, 1911

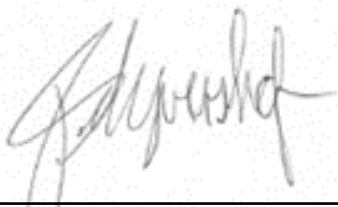
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<u>Client:</u>	Person: Chantel Muller Company: Enviroroots (Pty) Ltd Position: Managing Director Email: chantel.enviroroots@gmail.com / chantel@enviroroots.co.za Cell: 084 444 2414
<u>Compiled by:</u>	Person: Joppie Schrijvershof <i>Pri Sci Nat: 115553</i> <i>MSc (NWU- Aquatic Science)</i> Company: Oasis Environmental Specialists (Pty) Ltd. Position: Aquatic and Wetland Scientist Email: joppie@oasisenvironmental.co.za Tel: 016 987 5033 Cell: 076 589 2250
<u>Date:</u>	2018-05-16
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Joppie Schrijvershof

Executive summary

The purpose of this report is to summarise the riparian assessment findings for Desert Star Piggeries (Pty) Ltd. as per the letter received by the Breede-Gouritz catchment management agency (reference number 4/9/1/G40G/Farm 781) on the 27th September 2017 for the existing piggery units on Farm Caledon 781. The riparian assessment was conducted on 4th of May 2018 in order to assess the any riparian and wetland conditions and to expand baseline data for future reference. The farm portions are located 70 km east of Cape Town in the Western Cape Province.

The scope of work included:

- Identify and delineate any wetland areas and/or watercourses associated within the study boundary according to the Department of Water Affairs' "Practical field procedure for the identification and delineation of wetlands and riparian areas";
- Determine the Present Ecological Status (PES) of any identified wetlands and/or watercourses within a 500 m buffer around the existing piggery units and proposed slurry dams using Riparian Vegetation and Habitat Indices (namely VEGRAI and IHIA);
- Determine and assess the significance of the impacts caused by the proposed slurry dams and the piggery expansion on any associated wetlands or watercourses;
- Indicate the minimum buffer required to protect any wetland/ watercourse identified within the study site; and
- Identify possible impacts and recommend mitigation measures of the proposed development on the wetlands or watercourses within the study site.

A summary of the results obtained during the study:

The main findings of this report have been summarised below:

- i. A field investigation of the study area indicated a lack of hydric soil characteristics within the 500 m buffer.
- ii. The scope of this assessment was changed to delineate and classify channels and riparian areas associated with the area.
- iii. 'B' Section channels are subject to intermittent base flow and are considered hydrologically sensitive as they are associated with riparian habitats. Channels identified on site were categorised according to their differences in channel morphology (ephemeral, seasonal and perennial) and variations in the in-stream and riparian habitats. Two 'B' Section channels were identified and both classified as ephemeral. Baseflow within the channels ranged from limited to no flows; to very small isolated pools covered with algae.

- iv. Riparian vegetation associated with the channels has been significantly impacted upon crop cultivation.
- v. The riparian vegetation associated with the 'B' Section channels was assessed according to the Riparian Vegetation Response Assessment Index (VEGRAI) methods and all channels were found to be extensively modified (E Class).
- vi. As a result of no base-flow in any of the channels, a full aquatic assessment could not be conducted. Intermediate Habitat Integrity Assessment (IHIA) protocol, as described by Kemper. (1999) was however conducted on the habitats associated with the "B' Section channels.
- vii. The IHIA assessment was used to evaluate the instream and riparian habitat of the study area. The findings of the IHIA assessment revealed that instream and riparian habitat associated with the 'B' Section channels was extensively Modified (E class).
- viii. These poor scores is as a result of extensive crop cultivation, cattle trampling and overgrazing in the area, and an infestation of alien vegetation in the riparian zone.
- ix. A number of potential impacts relating to erosion, sedimentation, pollution and the continued spread of alien invasive species will potentially occur as a result of the proposed development.
- x. Mitigation measures associated with the proposed slurry dams and existing piggery expansion relate to minimising these impacts through the use of sustainable urban drainage systems, limiting instream sedimentation during the construction phase, the minimisation of pollutants entering the watercourses as well as limiting effects on faunal species that utilise the river.
- xi. The construction and operational phase was found to pose a low risk to the aquatic environment.
- xii. Further to this a 25 m buffer has been calculated for the drainage channels and 45 m for the Bot River in order to provide protection from any further development for the functions this wetland performs.
- xiii. Provided mitigation measures are to be implemented within an environmental management programme (EMPr) and the significance of any negative impacts reduced, which includes:
 - Water quality monitoring must take place quarterly during operation for the Bot and Leeu rivers;
 - Water quality assessments must be undertaken prior and after construction;
 - Active stormwater management must be implemented to stop silt and sediments from entering the aquatic system and smothering the habitat units;
 - Regular dam wall inspections;
 - Disturbed soils and stockpiled soils must be protected from erosional features; and
 - The prevention of alien invasive vegetation encroachment.

TABLE OF CONTENTS

1	INTRODUCTION	1
1.1	Background	1
1.2	Scope of work	1
1.3	Assumptions and Limitations.....	2
2	METHODOLOGY	5
2.1	Riparian Assessment	5
2.1.1	Desktop Assessment	5
2.1.2	Field Assessment.....	6
	Riparian Vegetation Response Assessment Index (VEGRAI)	9
	Intermediate Habitat Integrity Assessment.....	10
2.1.3	Significance and Risk of impacts	14
3	BACKGROUND INFORMATION.....	17
3.1	Climate	17
3.2	Vegetation	17
3.3	Geology	18
3.4	Quaternary catchment and Land Use.....	18
3.5	Ecoregion	19
4	RESULTS	26
4.1	Watercourse Delineation and Assessment.....	26
4.1.1	Desktop Assessment	26
4.1.2	Terrain Indicator.....	28
4.1.3	Soil wetness and soil form indicator.....	30
4.1.4	Vegetation indicator	33

4.1.5	Riparian Vegetation (VEGRAI).....	34
4.1.6	Habitat (IHIA)	34
5	IMPACTS.....	37
5.1	Sedimentation and Erosion	37
5.2	Impacts on water quantity and quality	38
5.3	Loss of Indigenous Vegetation	38
5.4	Mitigation	41
5.4.1	Construction phase	41
5.4.2	Operational phase.....	41
5.5	Risk Assessment.....	43
5.6	Wetland Buffer	45
6	CONCLUSION & RECOMMENDATIONS.....	47
	REFERENCES.....	48
	GLOSSARY	49

LIST OF TABLES

Table 1: Information used to inform the desktop assessment.....	6
Table 2: Intermediate habitat integrity and VEGRAI categories (Kleynhans, 1996).	10
Table 3: Criteria used in the assessment of habitat integrity (Kleynhans, 1996).	11
Table 4: Descriptive classes for the assessment of modifications to habitat integrity (Kleynhans, 1996).	13
Table 5: Criteria and weights used for the assessment of habitat integrity (Kleynhans, 1996).....	14
Table 6: Significance scoring used for each potential impact.	15
Table 7: Significance ratings matrix.....	16
Table 8: Sub-Quaternary reach desktop data (DWA, 2005).	19
Table 9: Southern Folded Mountains Ecoregion (19) attributes (DWAF, 2005).	20
Table 10: Information used to inform the wetland delineation for the wetlands identified within the Farm 781 Caledon study boundary.	31
Table 11: Riparian Ecological Category Scores.	34
Table 12: The average IHIA scores calculated for both the instream and riparian habitat for both the 'B' section channels...35	
Table 13: Scoring of each impact with and without mitigation measures for the construction phase for slurry dams and existing piggery expansions.	39
Table 14: Scoring of each impact with and without mitigation measures for the operational phase for the slurry dams and existing piggery expansions.	40
Table 15: Significance ratings matrix for the impacts associated with the proposed slurry dams and existing piggery extension	44

TABLE OF FIGURES

Figure 1: Locality of the Farm 781 Caledon.	3
Figure 2: Layout of the Farm 781 Caledon.....	4
Figure 3: Different zones of wetness found in wetlands, indicating how the soil wetness and vegetation indicators change (DWAF, 2005).	7
Figure 4: Different zones of wetness found in channels (DWAF, 2005).....	8
Figure 5: Farm 781 Caledon - Vegetation map.	22
Figure 6: Farm 781 Caledon - Catchment map.....	23
Figure 7: Farm 781 Caledon – Land-use map.	24
Figure 8: Farm 781 Caledon – Ecoregion map.	25
Figure 9: Farm 781 Caledon – NFEPA Wetlands map.	27
Figure 10: Farm 781 Caledon – Digital Elevation Model map.....	29
Figure 11: Clovelly soils were identified on the lower reaches of the study area.	32
Figure 12: Hutton soils were identified in the hilltops.	32
Figure 13: Overall view of hydrophytic vegetation associated with the Bot River confluence close to the Bot River confluence.	33
Figure 14: Farm 781 Caledon – Channels within 500 m.	36
Figure 15: Farm 781 Caledon – Buffer map.....	46

LIST OF ABBREVIATIONS AND ACCRONYMS

DEM:	Digital Elevation Model
DWS:	Department of Water Affairs and Sanitation
DWAF:	Department of Water Affairs and Forestry
EIS:	Ecological Importance and Sensitivity
IHIA:	Intermediate Habitat Integrity Assessment
MAP:	Mean Annual Precipitation
MAMSL:	Meters Above Mean Sea Level
NEMA:	National Environmental Management Act (107 of 1998) [as amended]
NFEPA:	National Freshwater Priority Area
NWA:	National Water Act (36 of 1998)
PES:	Present Ecological State
VEGRAI:	Riparian Vegetation Index
WUL:	Water Use Licence

1 INTRODUCTION

1.1 Background

Oasis Environmental Specialists (Pty) Ltd was appointed by Enviroroots (Pty) Ltd to conduct a riparian assessment report for Desert Star Piggeries (Pty) Ltd as per the letter received by the Breede-Gouritz catchment management agency (reference number 4/9/1/G40G/Farm 781) on the 27th September 2017 for the existing piggery units on Farm Caledon 781. The riparian assessment was conducted on 4th of May 2018 in order to assess the any riparian and wetland conditions and to expand baseline data for future reference. The farm portions are located 70 km east of Cape Town in the Western Cape Province (**Figure 1**).

Currently the farming development taps water from a number of boreholes which supply the farming development with water for irrigation activities, the piggery units and potable water. No water abstraction occurs from the Bot or the Swart rivers.

Further to this project which entails the development of two slurry dams and the expansion of piggery units on the property (**Figure 2**). The development area is situated in the Western Cape Province and falls within the quarter degree square 3419AC. The site is surrounded by existing agricultural activities.

1.2 Scope of work

The scope of work entailed to the Wetland Delineation and Assessment following:

- Summarisation of findings and recommendations. Field visit to delineate the outer boundary of wetland/riparian habitats within a 500 m buffer from the existing piggeries according to the methods contained in the manual 'A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas' (DWAF, 2005);
- Assess and describe the health of any watercourses identified, through evaluation of indexes of riparian vegetation and habitat indices;
- Delineation and description of any identified aquatic ecosystems and riparian vegetation;
- Determine the Present Ecological State (PES) of the channels associated with the site;
- Determine and assess the significance of the impacts caused by proposed slurry dams and existing piggery units on the delineated watercourses; and
- Provide recommended mitigation measures for the identified impacts in order to avert or lower the significance of the negative impacts, which includes a buffer using the methodology of MacFarlane *et al.* (2014).

1.3 Assumptions and Limitations

It is difficult to apply pure scientific methods within a natural environment without limitations, and consequential assumptions need to be made. The following constraints may have affected this assessment:

- A hand-held Garmin eTrex 30 were used to delineate the channels had an accuracy of 3-6 m.
- The use of vegetation as a wetland indicator could not be relied upon due to a significant infestation of alien invasive species which have completely changed the species composition of the riparian zone associated with the channels.
- Due to a lack of baseflow in any of the channels identified a full aquatic assessment could not be conducted.
- The findings, results, observations, conclusions and recommendations provided in this report are based on the author's best scientific and professional knowledge as well as available information regarding the perceived impacts on the wetlands.
- The assessment of the present ecological state (PES) was based on a single site visit. Site visits should ideally be conducted over differing seasons in order to better understand the hydrological and geomorphologic processes driving the characteristics of the watercourse.

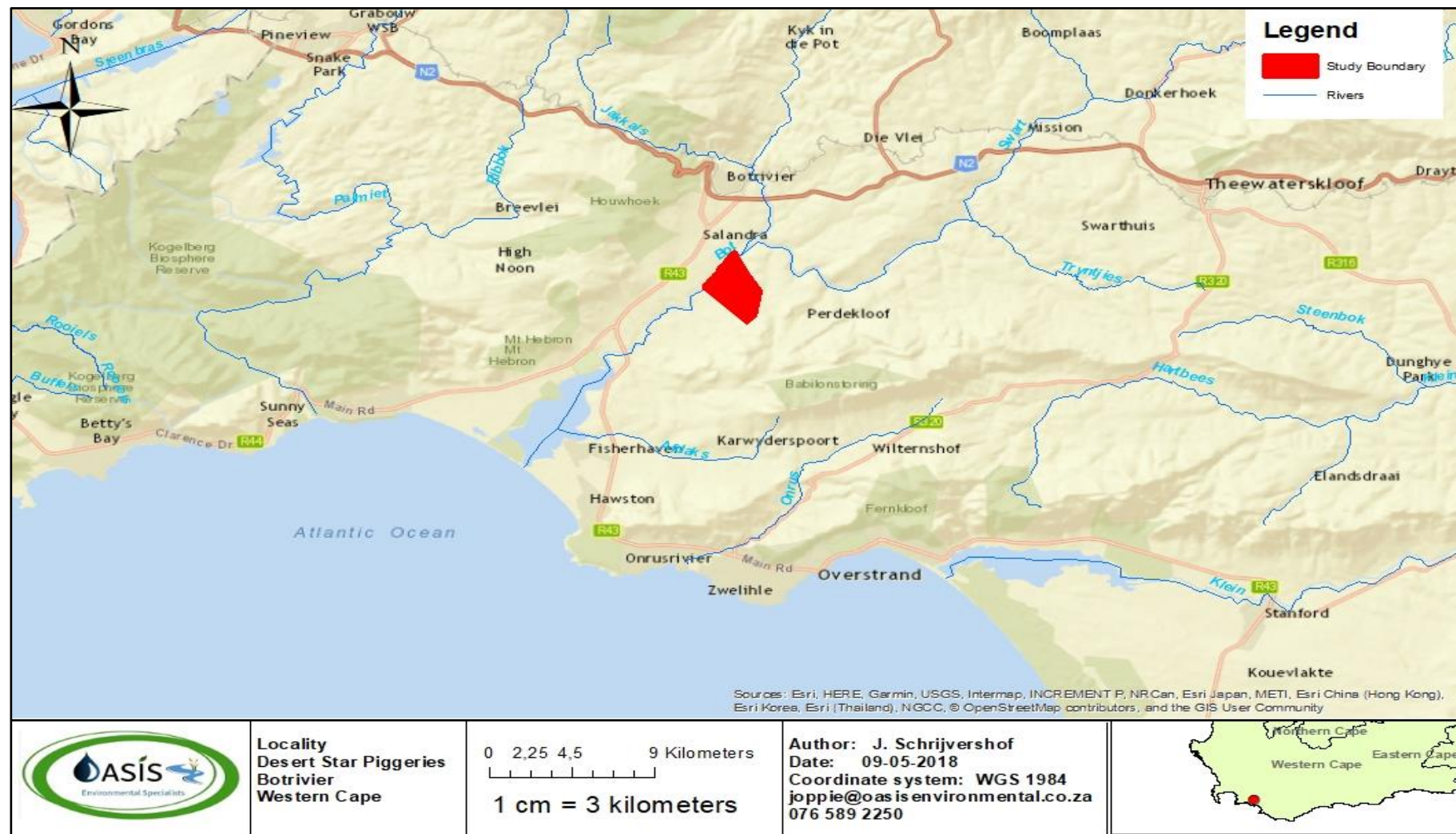


Figure 1: Locality of the Farm 781 Caledon.

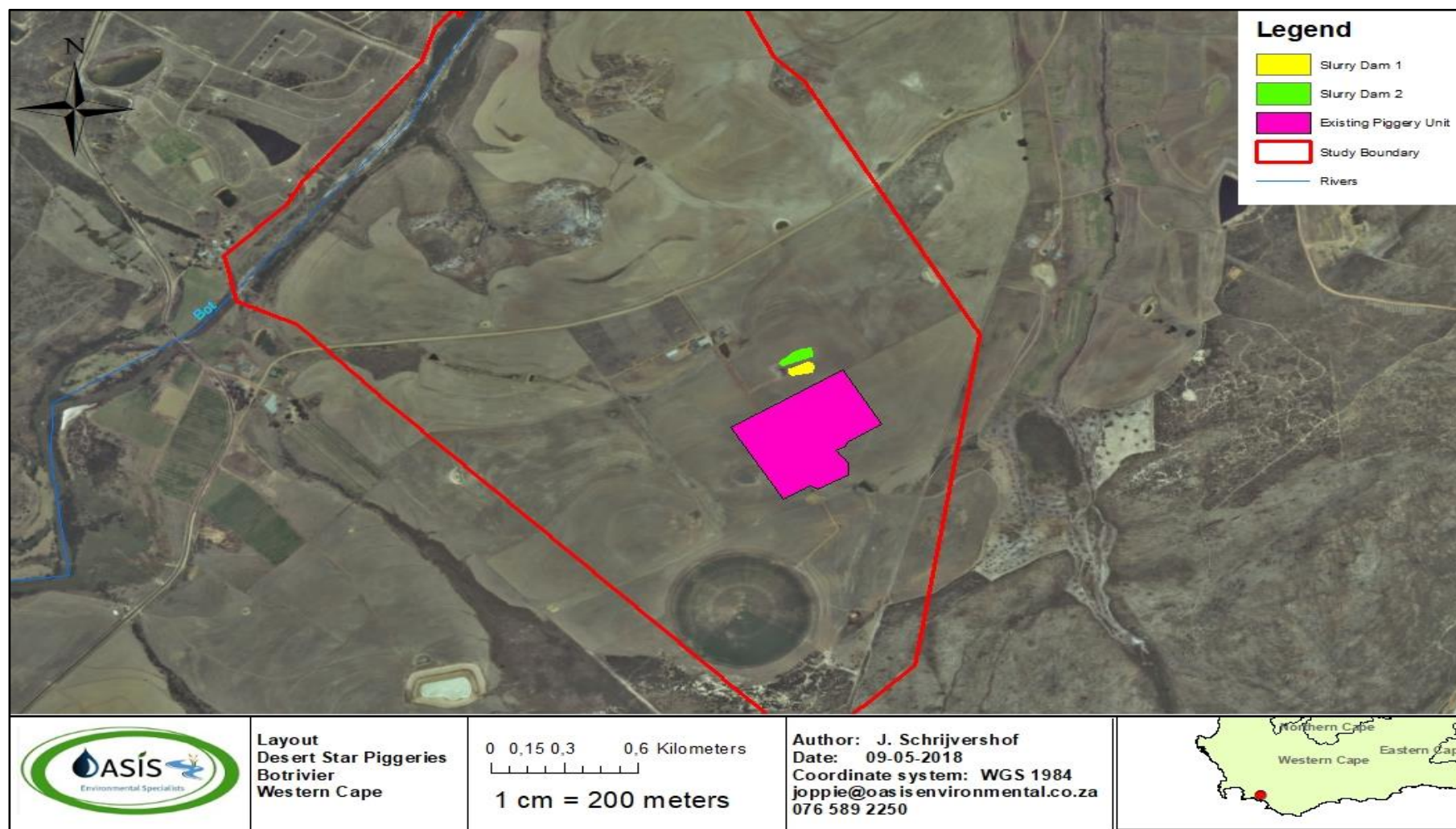


Figure 2: Layout of the Farm 781 Caledon.

2 Methodology

This section details the different techniques and methods utilised to obtain the data for this report in order to finally assess the aquatic conditions of the site based on the various inputs explained below.

2.1 Riparian Assessment

For the purpose of this assessment, wetlands are considered as those ecosystems defined by the National Water Act No. 36 of 1998 as:

“Land which is transitional between terrestrial and aquatic systems where the water table is usually at or near the surface, or the land is periodically covered with shallow water, and which land in normal circumstances supports or would support vegetation typically adapted to life in saturated soil.”

Riparian zones are considered as those ecosystems defined by the National Water Act No. 36 of 1998 as:

“Riparian habitat includes the physical structure and associated vegetation of the areas associated with a watercourse which are commonly characterised by alluvial soils and which are inundated or flooded to an extent and with a frequency sufficient to support vegetation of species with a composition and physical structure distinct from those of adjacent land areas.”

2.1.1 Desktop Assessment

Examination of the National Freshwater Ecosystem Priority Areas (NFEPA)'s databases were undertaken for the project. The NFEPA project aims to produce maps which provide strategic spatial priorities for conserving South Africa's freshwater ecosystems and supporting sustainable use of water resources. These strategic spatial priorities are known as Freshwater Ecosystem Priority Areas, or FEPAs. FEPAs are determined through a process of systematic biodiversity planning and involved collaboration of over 100 freshwater researchers and practitioners. They are identified based on a range of criteria dealing with the maintenance of key ecological processes and the conservation of ecosystem types and species associated with rivers, wetlands and estuaries (MacFarlane *et al.*, 2009).

The assessment of the study site involved the investigation of aerial photography, GIS databases including the NFEPA and South African National Wetland maps as well as literature reviews of the study site in order to determine the likelihood of wetland areas within this site.

The following data sources and GIS information provided in **Table 1** was utilised to inform the delineation.

Table 1: Information used to inform the desktop assessment.

DATA	USE	SOURCE
Latest and Historic Google Earth TM imagery	Used to assist with identifying potential areas within the study boundary for the presence of	Google Earth PRO TM On- line
River line	Mapping of watercourses outside of the study site.	Surveyor General
National Wetland Classification System	Assistance with information collection about the site and surrounding areas.	SANBI
National Freshwater Ecosystem Priority Area maps and database	Information gathering regarding the presence of FEPA wetlands on the site and within surrounding areas.	Water Research Commission, Implementation: Manual and Maps for FEPA area

2.1.2 Field Assessment

The watercourse delineation was conducted as per the procedures described in 'A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas – Edition 1' (Department of Water Affairs, 2005) (**Figure 3**). This document requires the delineator to give consideration to four indicators in order to find the outer edge of the wetland zone:

- The Terrain Unit Indicator helps to identify those parts of the landscape where watercourses are more likely to occur.
- The Soil Form Indicator identifies the soil forms, as defined by the Soil Classification Working Group (1991), which are associated with prolonged and frequent saturation.
- The Soil Wetness Indicator identifies the morphological "signatures" developed in the soil profile as a result of prolonged and frequent saturation. Signs of wetness are characterised by a variety of aspects. These include marked variations in the colours of various soil components, known as mottling; a gleyed soil matrix or the presence of Mn/Fe concretions. **It should be noted that the presence of signs of wetness within a soil profile is sufficient to classify an area as a wetland area despite the lack of other indicators.**
- The Vegetation Indicator identifies hydrophilic vegetation associated with frequently saturated soils.

In assessing whether an area is a wetland, the boundary of a wetland or a non-wetland area should be considered to be the point where the above indicators are no longer present. An understanding of the hydrological processes active within the area is also considered important when undertaking a wetland assessment. Indicators should be 'combined' to determine whether an area is a wetland, to delineate the boundary of that wetland and to assess its level of functionality and health.

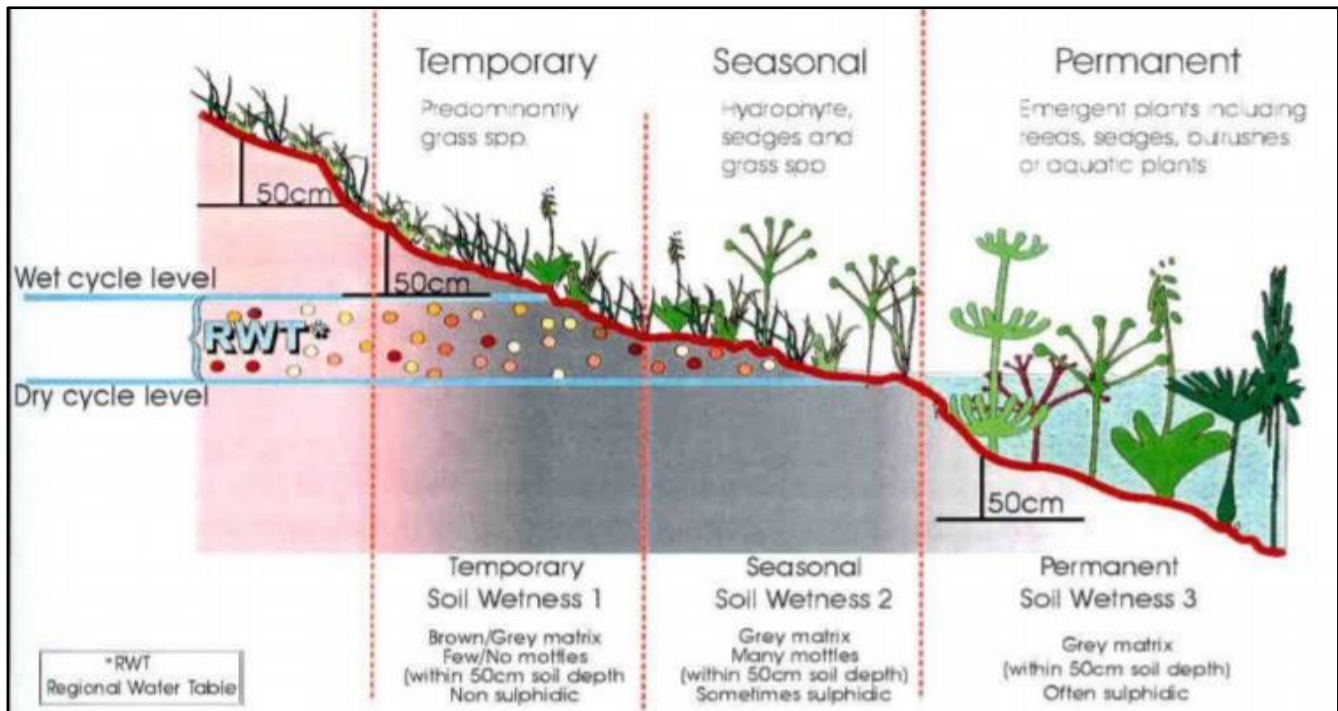


Figure 3: Different zones of wetness found in wetlands, indicating how the soil wetness and vegetation indicators change (DWAF, 2005).

Riparian areas were delineated based on topographic setting, vegetative indicators as well as the presence or absence of alluvial soils as described in 'A Practical Field Procedure for Identification and Delineation of Wetland and Riparian Areas – Edition 1' (DWAF, 2005) requirements. This manual separates the classification of watercourses into three (3) separate types of channels or sections defined by their position relative to the zone of saturation in the riparian area (**Figure 4**). The classification system separates channels into: those that do not have baseflow ('A' Sections); those that sometimes have baseflow ('B' Sections) or non-perennial or those that always have baseflow ('C' Sections) or perennial. 'A' Section channels convey surface runoff immediately after a storm event and are not associated with a riparian zone. 'B' Section channels are categorised as channels that sometimes have baseflow, dependant on rainfall events and are therefore non-perennial. They

are in contact with the zone of saturation often enough to have vegetation associated with saturated conditions as well as gleyed soil within the channel confines. 'B' Section channels are considered hydrologically sensitive as they are associated with riparian habitats.

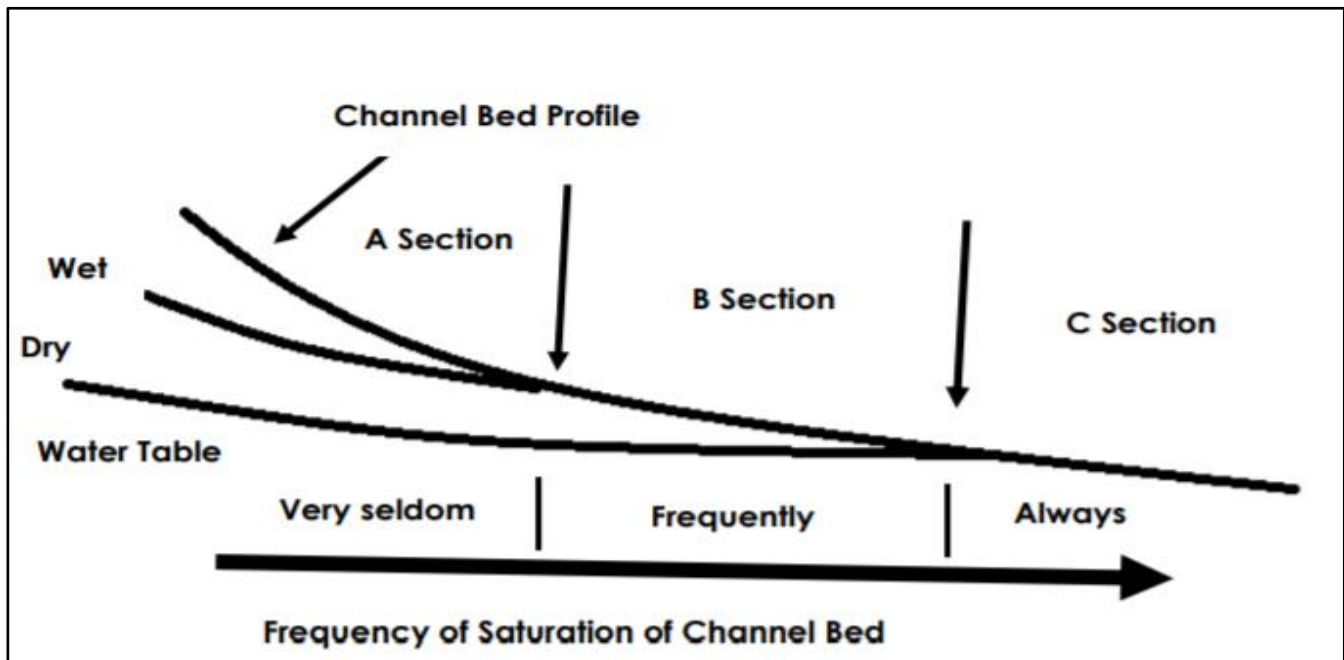


Figure 4: Different zones of wetness found in channels (DWAF, 2005).

Riparian areas perform numerous vital functions including the protection and enhancement of water resources through the following resources:

- Aiding in the storage of water and flood prevention;
- Stabilising stream banks;
- Improving water quality by trapping sediment and nutrients;
- Maintaining natural water temperatures for aquatic species;
- Providing foraging and roosting habitats for birds and other animals;
- Providing corridors for dispersal and migration of different species; and
- Acting as a buffer between aquatic ecosystems and adjacent land uses.

Riparian Vegetation Response Assessment Index (VEGRAI)

Riparian vegetation areas are divided into two sub-zones, marginal and non-marginal zones. This is important given that riparian vegetation distribution and species composition varies in different sub-zones, which has implications for flow-related impacts. The EC of the riparian zone is then assessed using the Riparian Vegetation Response Assessment Index (VEGRAI) level 3 (Kleynhans *et al.*, 2007).

Since all VEGRAI assessments are relative to the natural unmodified conditions (reference state) it is necessary and important to define and describe the reference state for the study area. This is done (in part) before going into the field, using historic aerial imagery, present and historic species distributions, general vegetation descriptions of the study area, any anecdotal data available and knowledge of the area and comparison of the study area characteristics to other comparable sections of the stream that might be in a better state. With this information, the reference (and present state) is quantified on site; the assessor reconstructs and quantifies the reference state from the present state by understanding how visible impacts have caused the vegetation to change and respond. Impacts on riparian vegetation at the site are then described and rated. It is important to distinguish between a visible / known impact (such as flow manipulation) and the response of riparian vegetation to other impacts such as erosion and sedimentation, alien invasive species and pollution. If there is no response to riparian vegetation, the impact is noted but not rated since it has no visible / known effect. These impacts are then rated according to a scale from 0 (No Impact) to 5 (Critical Impact). Once the riparian zone and sub- zones have been delineated, the reference and present states have been described and quantified (basal cover is used) and species description for the study area has been compiled, the VEGRAI metrics are rated and qualified (Kleynhans *et al.*, 2007).

The riparian ecological integrity was assessed using the spreadsheet tool that is composed of a series of metrics and metric groups, each of which is rated in the field with the guidance of data collection sheets. The metrics in VEGRAI describe the following attributes associated with both the woody and non-woody components of the lower and upper zones of the riparian zone:

- Removal of the riparian vegetation;
- Invasion by alien invasive species;
- Flow modification; and
- Impacts on water quality.

Results from the lower and upper zones of the riparian vegetation are then combined and weighted with a value that reflects the perceived importance of that particular criterion in determining habitat integrity, allowing this to be numerically expressed

in relation to the perceived benchmark. The score is then placed into one of six classes, namely A to F (Kleynhans *et al.*, 2007) (Table 2).

Table 2: Intermediate habitat integrity and VEGRAI categories (Kleynhans, 1996).

Category	Description	Score
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place but the ecosystem functions are essentially unchanged.	80-90
C	Moderately modified. A 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	The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39
F	Modifications have reached a critical level and the lotic 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

Intermediate Habitat Integrity Assessment

Habitat was assessed and characterised according to section D of the “Procedure for Rapid Determination of Resource Directed Measures for River Ecosystems, (Kemper, 1999)”.

The Intermediate Habitat Integrity Assessment (IHIA) model was used to assess the integrity of the habitats from a riparian and in-stream perspective. The habitat integrity of a river refers to the maintenance of a balanced composition of physico-

chemical and habitat characteristics on a temporal and spatial scale that are comparable to the characteristics of natural habitats of the region (Kleynhans 1996). The criteria used in the assessment of habitat integrity for the current study are presented in the **Table 3**.

Table 3: Criteria used in the assessment of habitat integrity (Kleynhans, 1996).

Criterion	Relevance
Water abstraction	Direct impact on habitat type, abundance and size. Implicated in flow, bed, channel and water quality characteristics. Riparian vegetation may be influenced by a decrease in the supply of water.
Flow modification	Consequence of abstraction or regulation by impoundments. Changes in temporal and spatial characteristics of flow have an impact on habitat attributes such as an increase in duration of low flow season, resulting in low availability of certain habitat types or water at the start of the breeding, flowering or growing season.
Bed modification	Regarded as the result of increased sediment from the catchment or a decrease in the ability of the river to transport sediment (Gordon <i>et al.</i> , 1993). Indirect indications of sedimentation are stream bank and catchment erosion. Purposeful alteration of the stream bed, e.g. the removal of rapids for navigation (Hilden & Rapport, 1993) is also included.
Channel modification	May be the result of a change in flow, which can alter channel characteristics causing a change in marginal instream and riparian habitat. Purposeful channel modification to improve drainage is also included.
Water quality modification	Originates from point and diffuse point sources. Measured directly or derived based on agricultural activities, human settlements and industrial activities may indicate the likelihood of modification. Aggravated by a decrease in the volume of water during low or no flow conditions.
Inundation	Destruction of riffle, rapid and riparian zone habitat. Obstruction to the movement of aquatic fauna and influences water quality and the movement of sediments (Gordon <i>et al.</i> , 1992).

Criterion	Relevance
Exotic macrophytes	Alteration of habitat by obstruction of flow and may influence water quality. This is dependent upon the species involved and scale of colonisation.
Exotic aquatic fauna	The disturbance of the stream bottom during feeding may influence the water quality and increase turbidity. Dependent upon the species involved and their abundance.
Solid waste disposal	A direct anthropogenic impact which alters habitat structurally. A general indication of the misuse and mismanagement of the river.
Indigenous vegetation removal	Impairment of the buffer the vegetation forms to the movement of sediment and other catchment runoff products into the river (Gordon et al., 1992). Refers to physical removal for farming, firewood and overgrazing.
Exotic vegetation encroachment	Excludes natural vegetation due to vigorous growth, causing bank instability and decreasing the buffering function of the riparian zone. Allochthonous ¹ organic matter input will be changed. Riparian zone habitat diversity is reduced.
Bank erosion	Decrease in bank stability will cause sedimentation and possible collapse of the river bank resulting in a loss or modification of both instream and riparian habitats. Increased erosion can be the result of natural vegetation removal, overgrazing or exotic vegetation encroachment.

The relevant criteria are then weighted and scored according to Kleynhans (1996), as seen in **Table 4**.

¹ denoting a deposit or formation that originated at a distance from its present position.

Table 4: Descriptive classes for the assessment of modifications to habitat integrity (Kleynhans, 1996).

Impact Category	Description	Score
None	No discernible impact or the modification is located in such a way that it 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 are also 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 influenced.	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 5: Criteria and weights used for the assessment of habitat integrity (Kleynhans, 1996).

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	TOTAL	100

Scores are then calculated based on ratings received from the assessment. The estimated impacts of the criteria (**Table 5**) are then summed and expressed as a percentage to arrive at a provisional habitat integrity assessment. The scores are placed into the Intermediate habitat integrity categories (Kleynhans, 1996) as seen in **Table 2**.

2.1.3 Significance and Risk of impacts

Significance scoring assesses and predicts the significance of environmental impacts through evaluation of the following factors; probability of the impact; duration of the impact; extent of the impact; and magnitude of the impact. The significance of environmental impacts is then assessed considering any proposed mitigations. The significance of the impact “without mitigation” is the prime determinant of the nature and degree of mitigation required. Each of the above impact factors have been used to assess each potential impact using ranking scales as seen in **Table 6**.

Impact scores given “with mitigation” are based on the assumption that the mitigation measures recommended in this assessment are implemented correctly and rehabilitation of the site is undertaken. Failure to implement mitigation measures will keep impacts at an unacceptably high level.

Unknown parameters are given the highest score (5) as significance scoring follows the Precautionary Principle. The Precautionary Principle is based on the following statement: *When the information available to an evaluator is uncertain as to whether or not the impact of a proposed development on the environment will be adverse, the evaluator must accept as a matter of precaution, that the impact will be detrimental. It is a test to determine the acceptability of a proposed development. It enables the evaluator to determine whether enough information is available to ensure that a reliable decision can be made.*

Table 6: Significance scoring used for each potential impact.

Probability	Duration
1 - very improbable	1 - very short duration (0-1years)
2 - improbable	2- short duration (2-5 years)
3 - probable	3 - medium term (5-15 years)
4 - highly probable	4 - long term (>15 years)
5 - definite	5 - permanent/unknown
Extent	Magnitude
1 - limited to the site	2 – minor
2 - limited to the local area	4 – low
3 - limited to the region	6 – moderate
4 - national	8 – high
5 - international	10 – very high

Significance Points = (Magnitude + Duration + Extent) x Probability. The maximum value is 100 Significance Points.

Potential Environmental Impacts are rated as high, moderate or low significance as per the following:

<30 significance points = Low environmental significance

31-59 significance points = Moderate environmental significance

>60 significance points = High environmental significance

The risk assessment was conducted in accordance with the DWS risk-based water use authorisation approach and delegation guidelines.

The matrix assesses impacts in terms of consequence and likelihood. Consequence is calculated based on the following formula:

$$\text{Consequence} = \text{Severity} + \text{Spatial Scale} + \text{Duration}$$

Whereas likelihood is calculated as:

$$\text{Likelihood} = \text{Frequency of Activity} + \text{Frequency of Incident} + \text{Legal Issues} + \text{Detection}.$$

Significance is calculated as:

$$\text{Significance \Risk} = \text{Consequence} \times \text{Likelihood}.$$

Each metric of the severity (flow regime, water quality, geomorphology, biota and habitat) and spatial scale, duration, frequency of the activity, frequency of the incident/impact and detection are rated to a 1 to 5 scale (GNR 509, of the National Water Act, 1998 (Act No. 36 of 1998) for Water Uses as Defined in Section 21(C) or Section 21(I), 2016).

The score is then placed into one of the three classes, with low risks to the watercourse will qualify for a General Authorisation (GA). Medium and high risk activities will require a Section 21(c) and (i) water use licence as per the National Water Act of 1998 (**Table 7**).

Table 7: Significance ratings matrix

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. Wetlands may be excluded.
56 – 169	(M) Moderate Risk	Risk and impact on watercourses are notably and require mitigation measures on a higher level, which costs more and require specialist input.
170 – 300	(H) High Risk	Always involves wetlands. Watercourse(s) impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve.

3 BACKGROUND INFORMATION

3.1 Climate

Altitude ranges between 60 – 450 m and MAP 360 –700 mm (mean: 490 mm), with winter rains from May to August. Mean daily maximum and minimum temperatures varies between 26.9°C and 6.1°C for February and July, respectively. Frost incidence about 3 days per year (Mucina & Rutherford, 2006; Scott-Shaw & Escott, 2011).

3.2 Vegetation

The vegetation within proximity included the Western Ruens Shale Renosterveld, Elim Ferricrete Fynbos and Overberg Sandstone Fynbos (**Figure 5**). Each one of these vegetation types are described below:

Western Ruens Shale Renosterveld

Western Ruens Shale Renosterveld is classified as 'Critically Endangered', where a conservation target of 27% of the original area has been set, but is unattainable due to the fact that $\pm 86\%$ has already been transformed, mostly by cultivation (Mucina & Rutherford, 2006). None of the area is conserved statutorily and only small portion (about 1%) enjoys protection in the Witdraai Private Nature Reserve. Only the steepest slopes carry remnants of this natural vegetation (Mucina & Rutherford, 2006).

Vegetation and landscape features are described as moderately undulating plains, today mostly stripped of natural vegetation and where preserved, supporting an open to medium dense, cupressoid and small-leaved, low to moderately tall grassy shrubland dominated by renosterbos (Mucina & Rutherford, 2006). This unit is distinguished from other Ruens renosterveld types by the absence of *Hermannia flammea* and rare occurrence of *Aloe ferox* and *Acacia karroo* complex. Shrubby *Asteraceae* (e.g. *Elytropappus rhinocerotis*) increase as grazing reduces the palatable grass component (mostly *Hyparrhenia hirta*), resulting in subsequent erosion.

Elim Ferricrete Fynbos

Extensive areas between the Bot River Valley, Hemel en Aarde Valley, Stanford environs, Salmonsdam and Baardskeerdersbos, with the most extensive parts around Elim on the Agulhas Plain spanning the area from Soetmuisberg in the north to Buffeljags and the Soetany'sberg in the south. Undulating hills and plains covered with open to closed dwarf shrubland with occasional scattered tall shrubs (Mucina & Rutherford, 2006). It is a diverse unit, with all structural fynbos types

present, but with extensive areas of asteraceous fynbos dominated by low proteoid elements (Mucina & Rutherford, 2006). To differentiate mesotrophic asteraceous from mesotrophic proteoid fynbos the following proteoid types are recognised: *Leucadendron elimense*, *L. laxum*, *L. modestum*, *L. stelligerum* and *L. teretifolium* (Mucina & Rutherford, 2006). When degraded, this vegetation type becomes dominated by *Elytropappus rhinocerotis* (Mucina & Rutherford, 2006). On transitions to deep sandy soils, *Protea repens* may be dominant, and these transitional communities are often much richer in species than associated Overberg Sandstone Fynbos (Mucina & Rutherford, 2006).

Overberg Sandstone Fynbos

Spread irregularly from Bot River and Hawston in the northwest to the Soetanysberg and Bredasdorp in the southeast, including the Caledon Swartberg, Babilonstoring, Kleinrivier and Bredasdorp Mountains and Agulhas hills such as Franskraal se Berge and Buffeljachtsberg Low Mountains, undulating hills and moderately undulating plains supporting moderately tall, dense restioid, ericoid-leaved and proteoid shrublands (Mucina & Rutherford, 2006). Structurally these are mainly proteoid and ericaceous fynbos, with restioid fynbos also occurring locally (Mucina & Rutherford, 2006).

3.3 Geology

Clays and loams derived from Bokkeveld Group shales, particularly the Ceres Subgroup. Glenrosa and Mispah forms are dominant. Land types mainly Fb and Fa. (Mucina & Rutherford, 2006).

3.4 Quaternary catchment and Land Use

The site falls within the Breede-Gouritz Water Management Area, where the Bot River flows adjacent to the farm portion, where no water abstraction for agricultural activities occur. The site falls within the water management area, within quaternary catchment G40G and G40F (**Figure 6**). Quaternary catchments are further subdivided into sub-quaternary reaches (or SQRs). The SQR in closest proximity to the site is G40E-09370. The desktop information for this SQR is display below in **Table 8**.

The most significant and on-going cause of biodiversity loss and deteriorating ecosystem health in the Western Cape and throughout South Africa is the conversion of the natural environment to artificial, manmade landscapes (DWA, 2005) (**Figure 7**). Such modification occurs through activities such as agriculture, forestry plantations, mining, infrastructure development and urban expansion (DWA, 2005). Agriculture is particularly intense in the Western Cape, covering 13 million hectares (ha), and producing approximately 45% of South Africa's agricultural exports (DWA, 2005). Land transformation effectively alters natural environments, resulting in the elimination, degradation and fragmentation of the remaining viable habitats (DWA, 2005). In the

Western Cape, habitat loss is mostly in the lowland areas with many of the terrestrial ecosystems now deemed critically endangered (DWA, 2005).

Table 8: Sub-Quaternary reach desktop data (DWA, 2005).

SQR		G40E-09370
Category	Name	Bot
	Length (km)	4,41
	Ecological importance	Moderate
	Ecological Sensitivity	Very High
	Present Ecological Status	Largely modified
	Class	D

3.5 Ecoregion

The Southern Folded Mountains (**Figure 8**) has a diverse topography with closed hills and mountains with a moderate to high relief (**Table 9**). The vegetation is likewise highly diverse with various Fynbos, Karoo, Renosterveld and Thicket types, but Mountain Fynbos, Grassy Fynbos and Little Succulent Karoo are generally distinctive. The Gourits River and its main tributaries traverse this area. Other significant rivers include the Palmiet, Gamtoos and its tributaries, Keurbooms, Kromme, Rivier-Sonder-End and the Breede rivers. The Berg River has its source in this region.

- Mean annual precipitation: Generally low but moderate to high towards the south.
- Coefficient of variation of annual precipitation: Moderate to high.
- Drainage density: Predominantly medium but low in some areas.
- Stream frequency: Medium/high to low/medium.
- Slopes <5%: Mostly <20%.

- Median annual simulated runoff: Varies from low to very high but predominantly moderate.
- Mean annual temperature: Moderate but low in patches.

Table 9: Southern Folded Mountains Ecoregion (19) attributes (DWAF, 2005).

Main attributes	Southern Folded Mountains
Terrain morphology: Broad division (dominant types in bold) (Primary)	Plains; Low Relief (limited); Plains Moderate Relief (limited); Lowlands; Hills and Mountains; Moderate and High Relief; Open Hills; Lowlands; Mountains; Moderate to High Relief; Closed Hills; Mountains; Moderate and High Relief
Vegetation types (Dominant types in bold)	Patches Afromontane Forest; Xeric Succulent Thicket (limited); Valley Thicket (limited); Spekboom Succulent Thicket; Grassy Fynbos; Mountain Fynbos; Limestone Fynbos; Sand Plain Fynbos (Limited); South and South West Coast Renosterveld; Central Mountain Renosterveld; West Coast Renosterveld (very limited) Eastern Mixed Nama Karoo; Central Nama Karoo; Great Nama Karoo (limited); Eastern Thorn Bushveld (very limited); Little Succulent Karoo; Lowland Succulent Karoo (very

Main attributes	Southern Folded Mountains
	limited);
Altitude (m.a.m.s.l) (secondary)	0-300 limited; 300-1900, 1900-2100 (limited)
MAP (mm) (modifying)	100 to 1500
Coefficient of Variation (% of annual precipitation)	<20 to 40
Rainfall concentration index	<15 to 55
Rainfall seasonality	Very late summer to winter to all year
Mean annual temp. (°C)	10 to 20
Mean daily max temp. (°C) February	18 to 32
Mean daily max temp. (°C) July	10 to 22
Mean daily min. temp. (°C): February	10 to 20
Mean daily min. temp. (°C): July	0 to 10
Median annual simulated runoff (mm) for quaternary catchment	<5 to >250

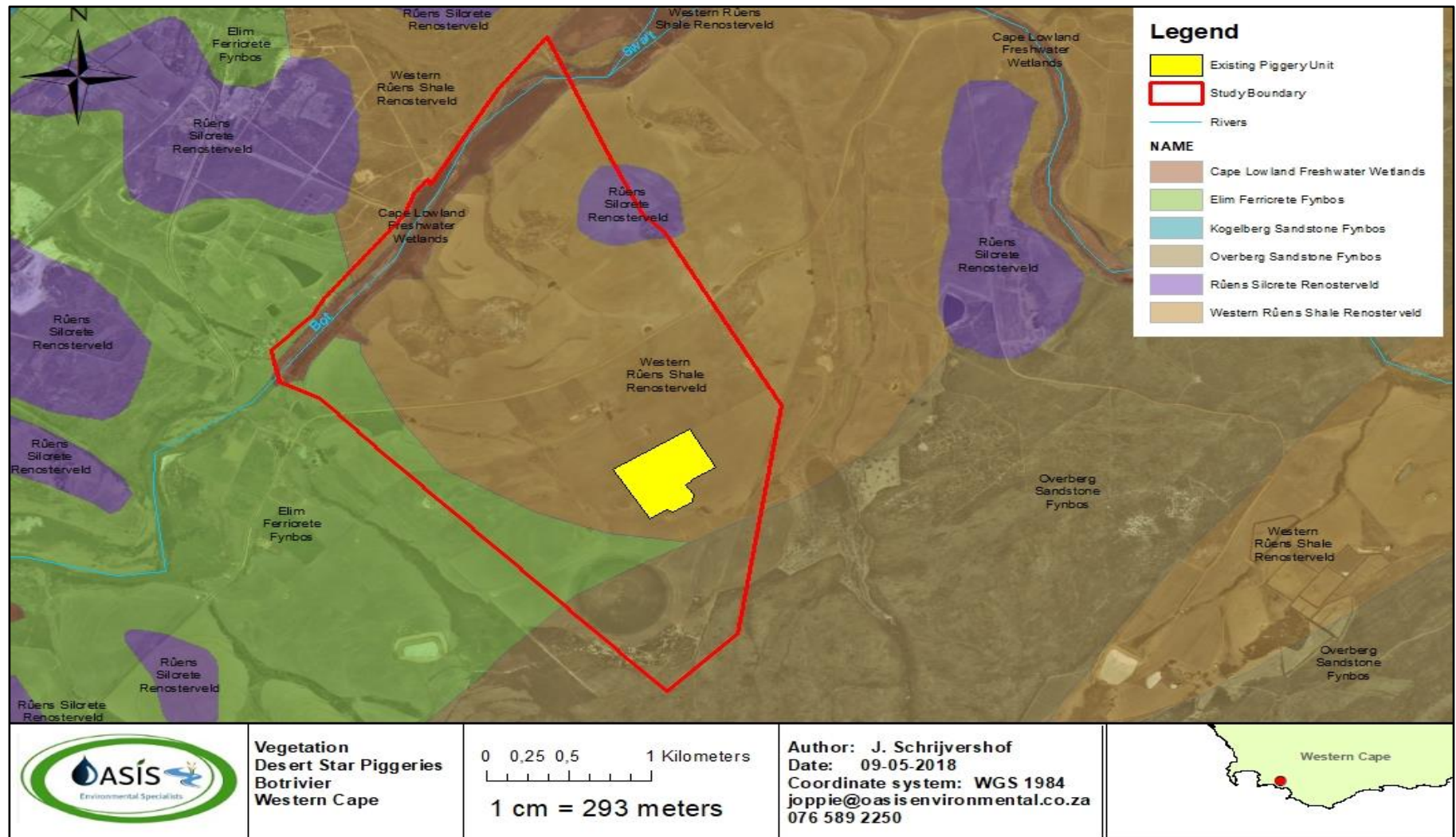


Figure 5: Farm 781 Caledon - Vegetation map.

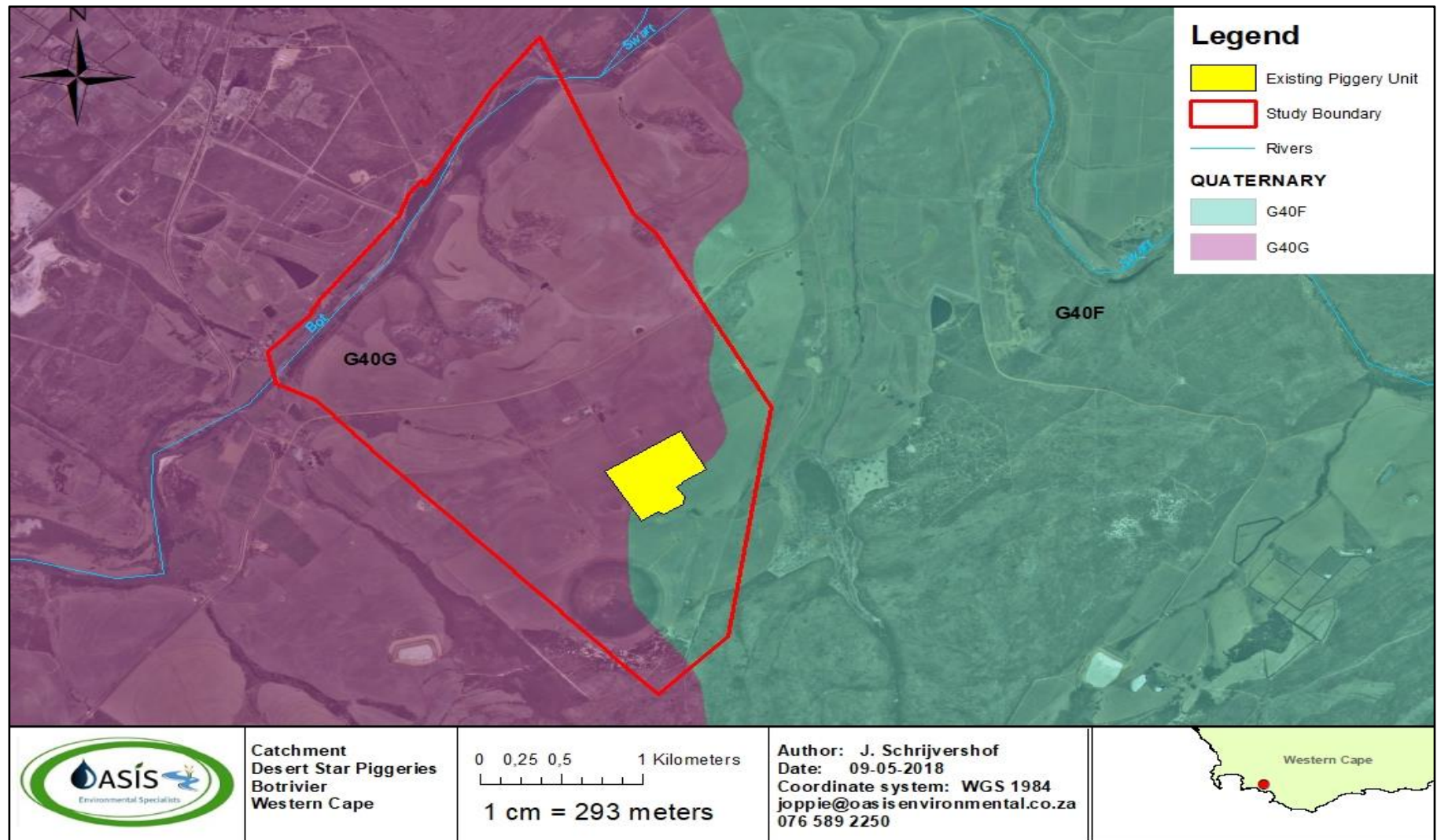


Figure 6: Farm 781 Caledon - Catchment map.

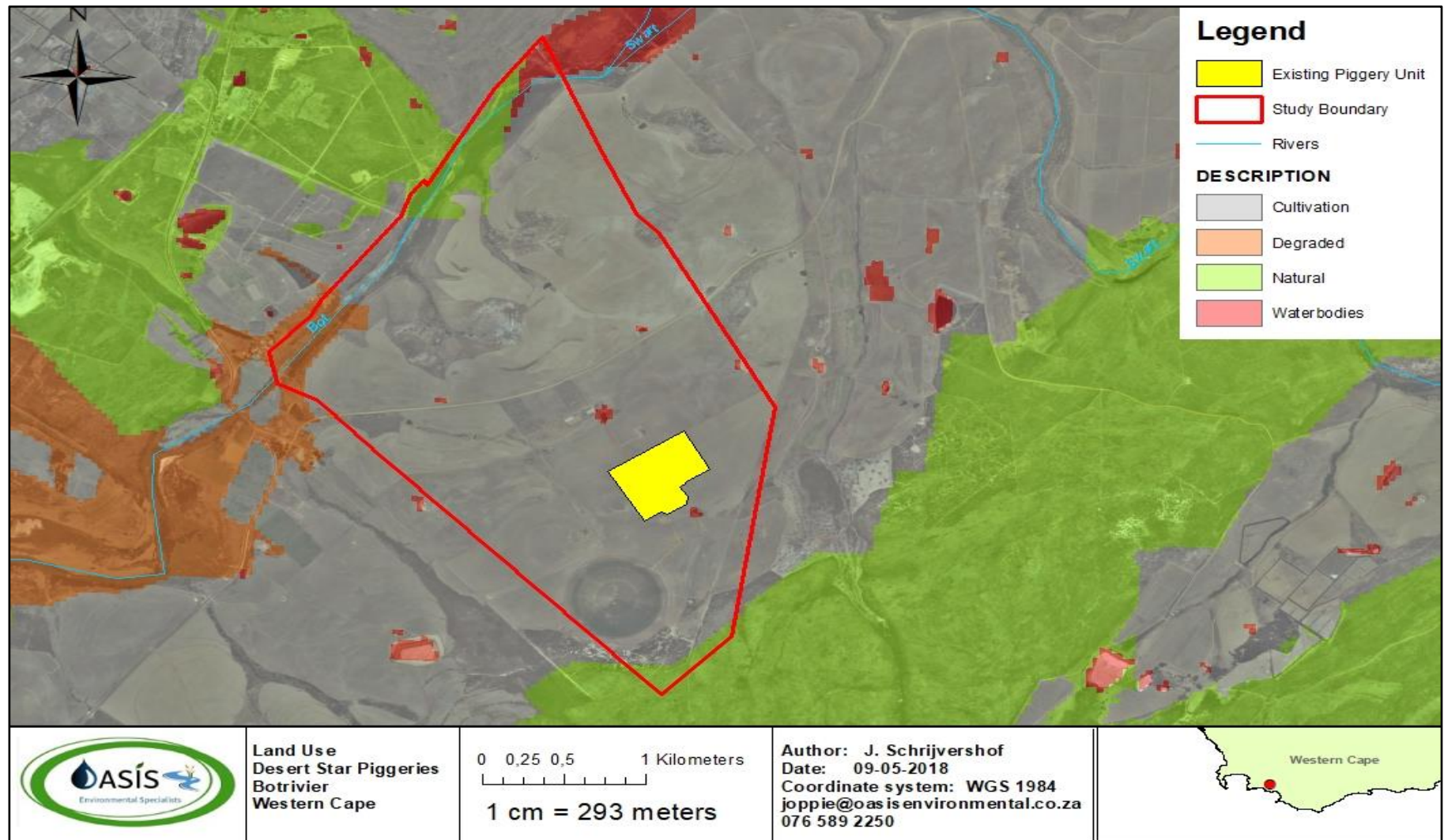


Figure 7: Farm 781 Caledon – Land-use map.

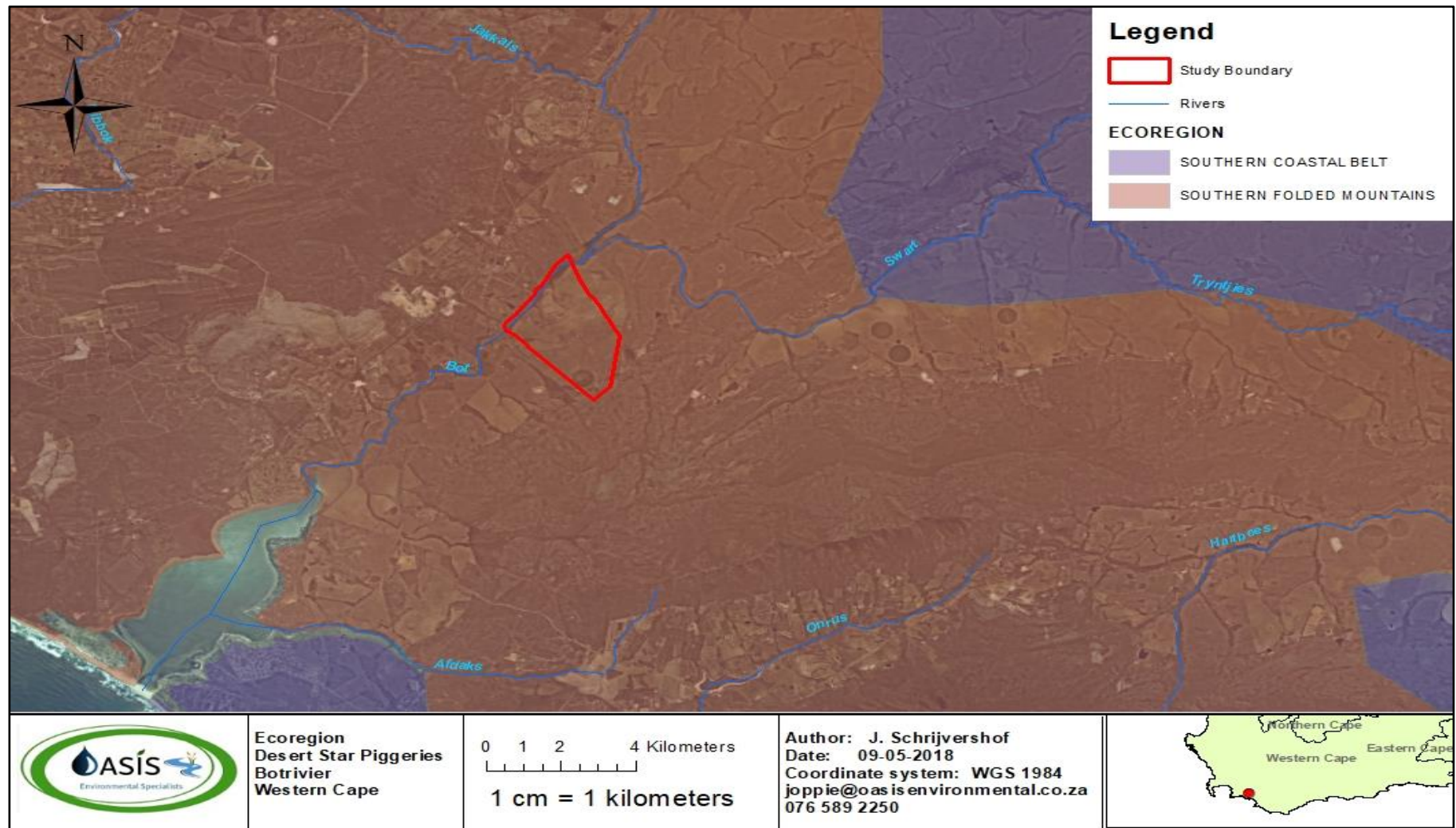


Figure 8: Farm 781 Caledon – Ecoregion map.

4 RESULTS

4.1 Watercourse Delineation and Assessment

The field assessment took place on the 4th of May 2018. This section provides the findings of the various methodologies utilised during the assessment.

4.1.1 Desktop Assessment

Examination of the National Freshwater Ecosystem Priority Areas (NFEPA) database were undertaken for the existing piggeries. The NFEPA project aims to produce maps which provide strategic spatial priorities for conserving South Africa's freshwater ecosystems and supporting sustainable use of water resources. They are identified based on a range of criteria dealing with the maintenance of key ecological processes and the conservation of ecosystem types and species associated with rivers, wetlands and estuaries (MacFarlane *et al.*, 2009). Identification of FEPA Wetlands is based on a combination of special features and modelled wetland conditions that include expert knowledge on features of conservation importance as well as available spatial data on the occurrence of threatened frogs and wetland-dependent birds.

Valley bottom NFEPA wetlands were identified within the project boundary on the NFEPA database during the desktop assessment. However, the site visit proved that these wetlands were found to be the existing dams on the farm (**Figure 9**). The only watercourse associated with the area is the Bot River in the form of a Valley Floor Floodplain Wetland according to the NFEPA database. The Bot River, however does not fall within the 500 m buffer of the proposed activities.

However, ground-truthing the existence and condition of FEPA wetlands is important to understand local conditions which have an impact on the wetland system, their functional integrity and health.

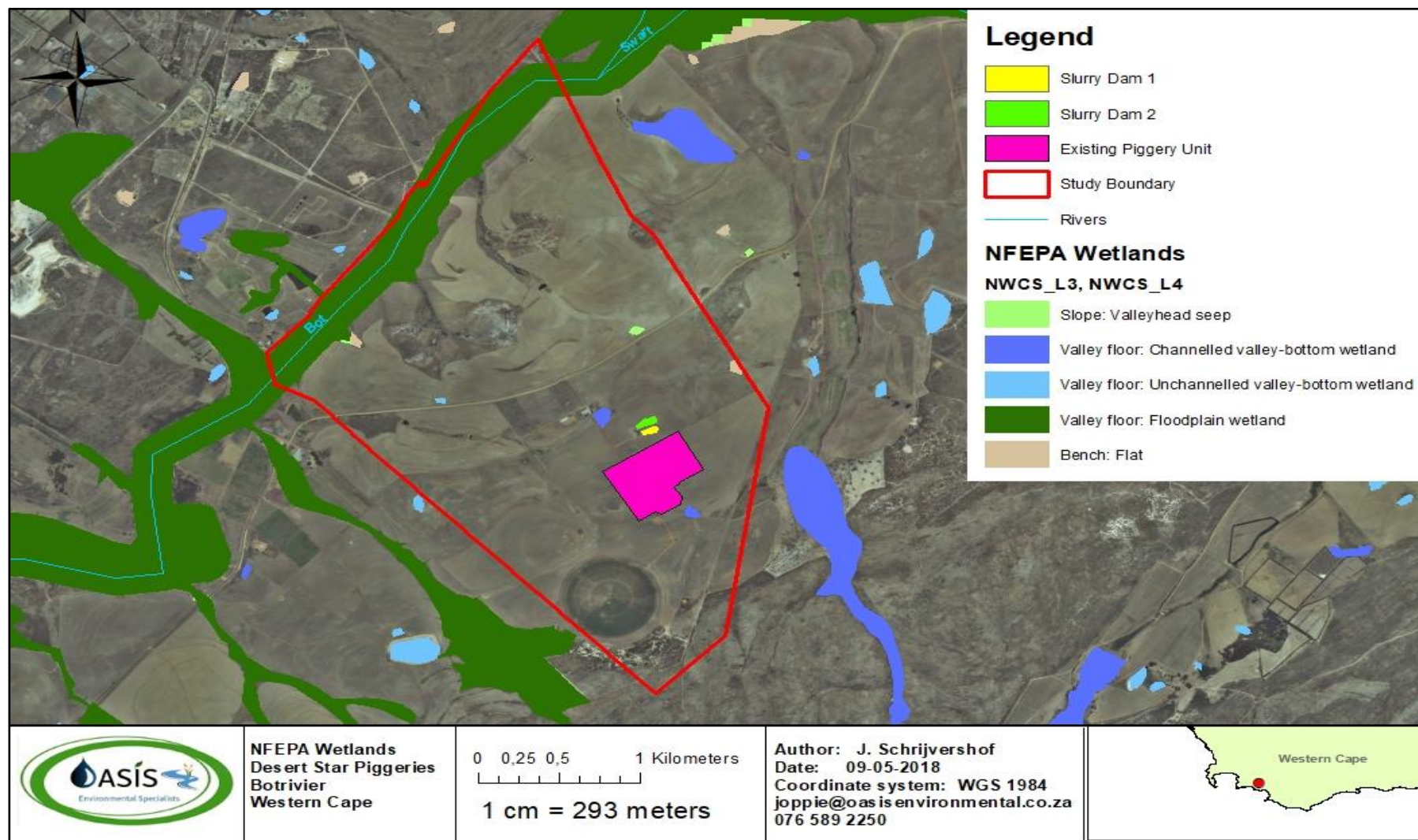


Figure 9: Farm 781 Caledon – NFEPA Wetlands map.

4.1.2 Terrain Indicator

The topography of an area is generally a good practical indicator for identifying those parts in the landscape where wetlands are likely to occur. In order to classify a watercourse, the localised landscape setting must be taken into consideration through ground-truthing of the study site after initial desktop investigations (Ollis *et al.*, 2014).

The study site can be characterised as having rolling hills with relatively steep sloping topography on the southern portion of the study area. A Digital Elevation Model (DEM) of the aerial photography of the site revealed drainage channels associated with the Bot River (**Figure 10**). The two main drainage channels within the 500 m buffer of the proposed activities were identified during the desktop assessment, where they were assessed in more detail during the field investigation and confirmed to be 'B' Section channels.

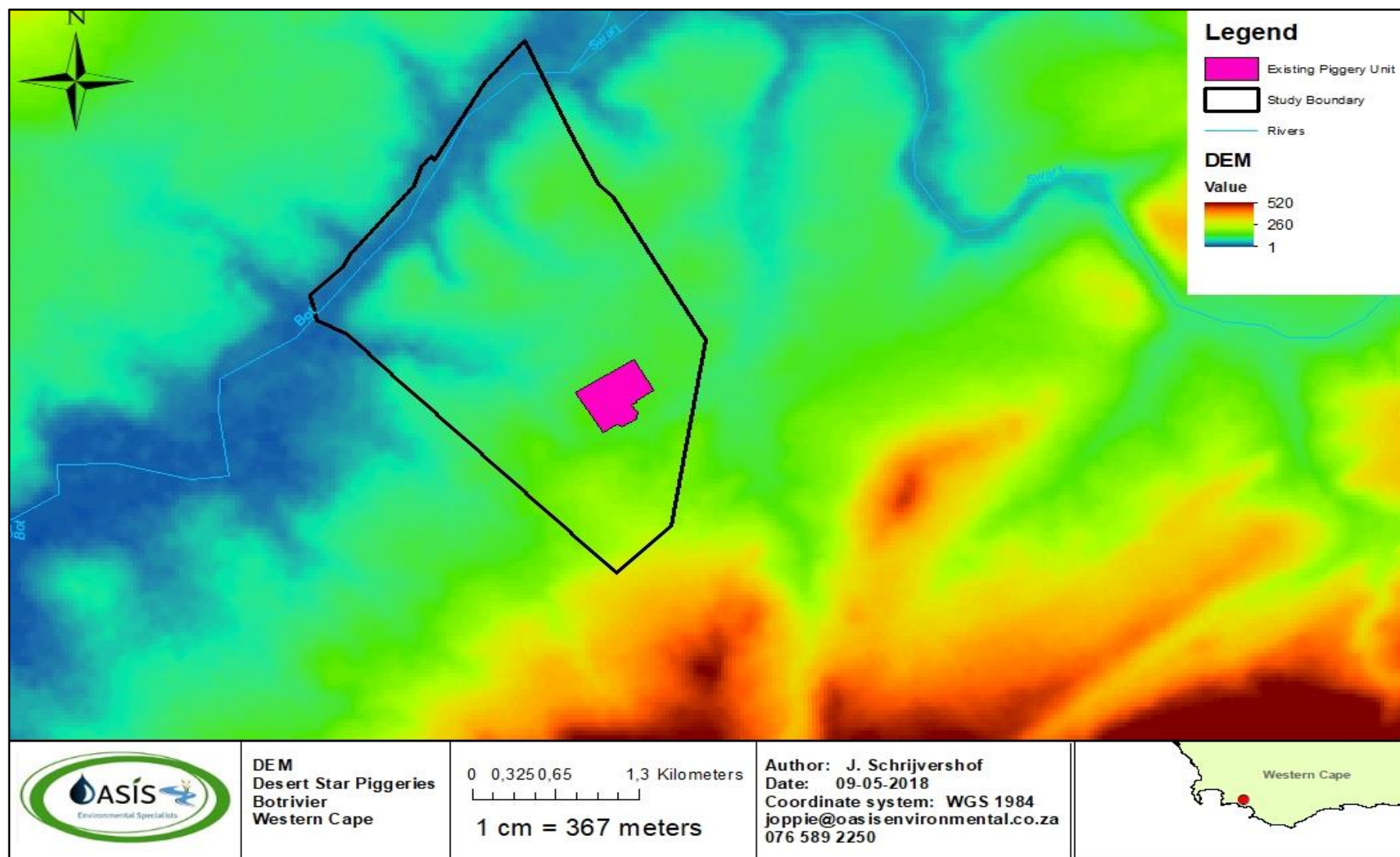


Figure 10: Farm 781 Caledon – Digital Elevation Model map.

4.1.3 Soil wetness and soil form indicator

Wetland areas are delineated according to the presence of hydric (wetland) soil types. Hydric soils are defined as those which show characteristics (redoximorphic features) resulting from prolonged and repeated saturation. Characteristics include the presence of mottling (i.e. bright insoluble manganese and iron compounds) a gleyed matrix and/or Mn/Fe concretions.

No iron deposits (mottling) were identified within soil samples taken within the wetland areas. The presence of redoximorphic features are the most important indicator of wetland occurrence, as these soil wetness indicators remain in wetland soils, even if they are degraded or desiccated (DWAF, 2005). Redoximorphic features are soil characteristics which develop as a result of prolonged and repeated saturation. It is important to note that the presence or absence of redoximorphic features within the upper 500 mm of the soil profile alone is sufficient to identify the soil as being hydric, or non-hydric (Collins, 2005).

No hydric soils were identified within the site. Terrestrial soils sampled were dominated by Clovelly (**Figure 11**) and Hutton (**Figure 12**). Mispah soils were identified outside on the mountain rocky outcrops. Soil properties identified on site are shown below (**Table 10**).

Table 10: Information used to inform the wetland delineation for the wetlands identified within the Farm 781 Caledon study boundary.

Soil Form and Horizons		Soil	Zone of wetness	Observations
Terrestrial Soils				
Clovelly	Orthic A	Sandy	None	Yellow structureless soil with no signs of saturation observed. No mottling was observed in the profiles examined
	Yellow-brown Apedal			
Hutton	Orthic A	Sandy	None	Red apedal soils identified on the tops of hills. No mottling was identified in these soils as the sandy nature of the soils ensures a quick infiltration of surface water.
	Red Apedal			
Mispah	Orthic A	Rocky and sandy	None	Identified outside on the rocky mountainous areas. Shallow in nature and not hydric.
	Rocky			



Figure 11: Clovelly soils were identified on the lower reaches of the study area.



Figure 12: Hutton soils were identified in the hilltops.

4.1.4 Vegetation indicator

According to DWAF (2005), vegetation is regarded as a key component to be used in the delineation procedure for wetlands. Vegetation also forms a central part of the wetland definition in the National Water Act, Act 36 of 1998. However, using vegetation as a primary wetland indicator requires an undisturbed condition (DWAF, 2005). Extensive agricultural activities made it difficult to rely solely on vegetation as a wetland indicator. Disturbances included the presence of minor alien invasive species, minor erosion, extensive grazing and crops within the area.

Two hydrophytic species were identified within one of the 'B' section (**Figure 13**), these hydrophytic riparian vegetation consisted of mainly of *Phragmites australis* (Common Reed) and *Juncus spp.* in the lower part of Channel 2 close to the Bot River confluence, outside of the 500 m buffer of the proposed activities (**Figure 14**).



Figure 13: Overall view of hydrophytic vegetation associated with the Bot River confluence close to the Bot River confluence.

4.1.5 Riparian Vegetation (VEGRAI)

The riparian ecological integrity was assessed for the 'B' section channel using the Riparian Vegetation Response Assessment Index (VEGRAI) (Kleynhans *et al.*, 2008).

Results from the lower and upper zones of the riparian vegetation are then combined and weighted with a value that reflects the perceived importance of that particular criterion in determining habitat integrity, allowing this to be numerically expressed in relation to the perceived benchmark. These values are then summed to produce a score that reflects the overall habitat integrity of the riparian unit. The score is then placed into one of six classes (**Table 11**).

Table 11: Riparian Ecological Category Scores.

Unit	Score (%)	Class	Confidence
'B' Section Channel 1	26,2	E	3,5
'B' Section Channel 2	36,4	E	3,2

The riparian habitat associated with the 'B' Section channels has been classified as seriously modified, Class E with a large loss of natural habitat, biota and basic ecosystem functions due to extensive crop farming and the removal of indigenous vegetation. Some alien invasive plant species were recorded in the lower reaches of Channel 2.

4.1.6 Habitat (IHIA)

The findings of the IHIA assessment revealed that instream and riparian habitat associated with the channel assessed is Seriously Modified (Class E) for the 'B' section streams (**Table 12**). Direct disturbance from the extensive crop farming, cattle trampling, overgrazing and extensive erosion in the area, and alien vegetation in the riparian and instream zone were the main impacts on the channels.

Table 12: The average IHIA scores calculated for both the instream and riparian habitat for both the 'B' section channels.

INSTREAM CRITERIA	WEIGHT	Channel 1	Channel 2	Average	Score
Water abstraction	14	18	17	17,5	9,8
Flow modification	13	18	18	18	9,36
Bed modification	13	16	14	15	7,8
Channel modification	13	19	18	18,5	9,62
Water quality	14	9	8	8,5	4,76
Inundation	10	5	5	5	2
Exotic macrophytes	9	19	17	18	6,48
Exotic fauna	8	20	20	20	6,4
Solid waste disposal	6	12	12	12	2,88
TOTAL	100				40,9
RIPARIAN ZONE CRITERIA	WEIGHT	Channel 1	Channel 2	Average	Score
Indigenous vegetation removal	13	24	22	23	11,96
Exotic vegetation encroachment	12	20	20	20	9,6
Bank erosion	14	15	12	13,5	7,56
Channel modification	12	20	18	19	9,12
Water abstraction	13	18	16	17	8,84
Inundation	11	8	7	7,5	3,3
Flow modification	12	18	16	17	8,16
Water quality	13	10	10	10	5,2
TOTAL	100				36,26
IHIA Score					38,58

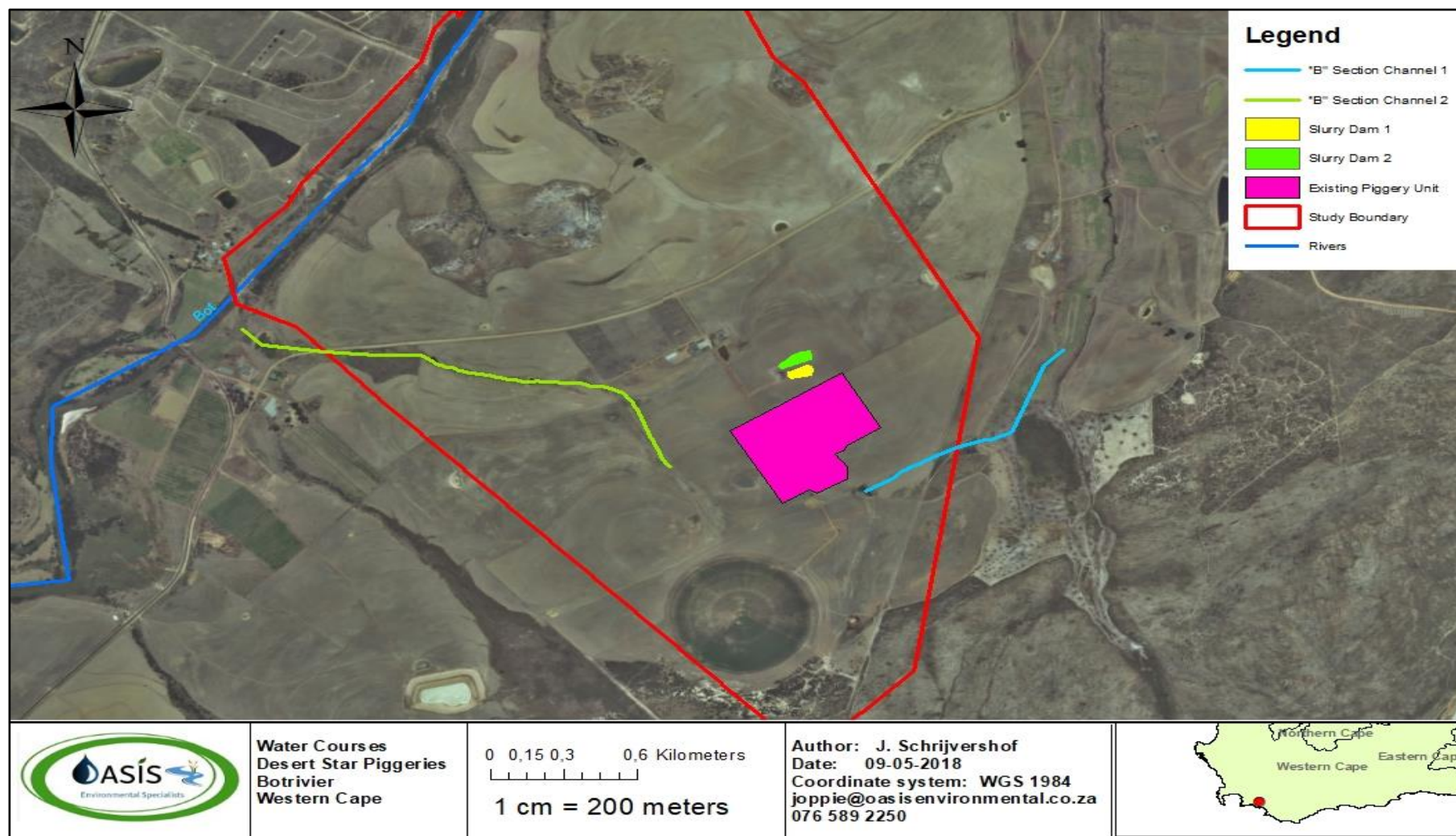


Figure 14: Farm 781 Caledon – Channels within 500 m.

5 IMPACTS

Any development activity in a natural system will have an impact on the surrounding environment, usually in a negative way. The purpose of the impact assessment is to identify and assess the significance of the current impacts likely to be caused by the proposed slurry dams and existing piggery unit expansion to the channels and to provide a description of the mitigation required in order to minimise or offset any such potential impacts on the natural environment.

Impacts that have been identified are predominantly associated with cumulative impacts include increased levels of erosion, proliferation of alien invasive species and water quality alterations. Mitigation measures stated must be used to minimise the ecological impacts of the operational process.

The management phase of the development must include water quality surveys of aquatic habitats (namely the Bot River) to determine the extent of functionality of the mitigation measures provided. Mitigation actions and scores are listed in **Section 5.4, Table 13 and Table 14**, which outlines the construction and operational impacts before and after mitigation actions have been imposed.

The gradual slope of the banks of the ponds, will increase the use of this area by grazing livestock who will drink from the permanent standing water. This will lead to increased trampling and erosion, resulting in sediment transportation into the aquatic habitat. Soil disturbances will encourage the occurrence of exotic/alien invasive vegetation, which will require active management. During the operation of the *E. coli* variables must be assessed as part of a quarterly water quality monitoring program.

5.1 Sedimentation and Erosion

The construction phase of the proposed slurry dams will increase the transport of sediment to the watercourse, during flooding events which will increase the turbidity within the system. Increased sediments will settle on the substrate, which will restrict and displace substrate-dwelling species, these impacts can be mitigated to a limited degree.

Stormwater management needs to take into consideration the deposition of silts transported after rainfall events into the surface water resources, again leading to smothering of the aquatic habitat, ultimately displacing aquatic species. Erosion must be strictly controlled through the utilisation of silt traps, silt fencing, gabions, etc. This is especially pertinent within areas of steeper gradients. Some impacts are inevitable due to the very nature of the impact for e.g. grazing. The most significant impacting features will result from the further fragmentation of the river habitat and the consequences to aquatic communities and conservation within the region.

5.2 Impacts on water quantity and quality

Dam construction may alter the physicochemical components of the watercourse. This includes a decrease in oxygen content, increase in electrical conductivity, total dissolved solids, and altered pH and temperatures. Changes in the physicochemical properties of the watercourse can alter the community structure of the aquatic biota, thereby impacting on biodiversity.

Due to the nature of piggeries, the potential will be there of organic waste entering the wetland and Bot River directly or indirectly during the operations phase. Without careful management and water quality monitoring there is a risk that waste water may enter the environment and further contaminate wetland and riverine areas, but this may be very limited or eradicated, when applying the correct mitigation measures as prescribed. Untreated waste water entering wetland/river areas will impact negatively on the integrity and functioning of the aquatic ecosystems (including vegetation and living organisms) and could have a negative impact on downstream water resources. Large amounts of nutrients and bacteria associated with waste water discharge can result in reductions in water quality, disruption of trophic pathways, increased algal blooms and reduction in dissolved oxygen levels, impacting on aquatic biotic diversity and generally leading to the degradation of the wetland area affected (MacFarlane *et al.*, 2009).

5.3 Loss of Indigenous Vegetation

Alien invasive plants have the ability to out-compete and replace indigenous flora, which will in turn impact on natural biodiversity. Edge habitat is characterised by a predominance of generalist and alien species that are usually highly competitive species which can invade areas of established vegetation, resulting in a loss of sedentary species of mature habitats which are normally considered sensitive. In addition, certain alien plants exacerbate soil erosion whilst others contribute to a reduction in stream flows. Although the impact is initiated during the construction phase, it is really an operational issue as recovery of vegetation community types is a long-term process. The significance of this impact is negated by the existing disturbance regime in the project area, characterised by already dense infestations of alien plants in riparian areas and wetlands (MacFarlane *et al.*, 2009).

A suitable alien invasive eradication and management programme must be implemented to prevent any further spread of alien invasive plants.

Table 13: Scoring of each impact with and without mitigation measures for the construction phase for slurry dams and existing piggery expansions.

Impacts associated with the pre-construction and construction phase of the activities										
Impact	Probability		Duration		Extent		Magnitude		Significance scoring without mitigation	Significance scoring with mitigation
	Without mitigation	With mitigation	Without mitigation	With mitigation	Without mitigation	With mitigation	Without mitigation	With mitigation		
Construction Phase										
Sedimentation and Erosion	3	3	2	1	2	1	6	4	30 (LOW)	18 (LOW)
Impacts to Water Quality	3	3	2	1	2	1	6	4	30 (LOW)	18 (LOW)
Loss of Indigenous Vegetation and Habitat	3	3	1	1	2	1	6	4	24 (LOW)	18 (LOW)

Table 14: Scoring of each impact with and without mitigation measures for the operational phase for the slurry dams and existing piggery expansions.

Impacts associated with the operational phase of the activities										
Impact	Probability		Duration		Extent		Magnitude		Significance scoring without mitigation	Significance scoring with mitigation
	Without mitigation	With mitigation	Without mitigation	With mitigation	Without mitigation	With mitigation	Without mitigation	With mitigation		
Operational Phase										
Sedimentation and Erosion of Watercourses	3	2	4	4	2	1	4	4	30 (LOW)	18 (LOW)
Impacts to Water Quality	3	2	4	4	2	1	6	4	36 (MODERATE)	18 (LOW)
Loss of Indigenous Vegetation and Habitat	3	2	4	4	2	1	4	4	30 (LOW)	18 (LOW)

5.4 Mitigation

5.4.1 Construction phase

- Ensure that all stockpiles are well managed and have measures such as to minimise the mobilisation of sediments by the use of sand bags, hessian sheets, etc.;
- Dumping of any excess rubble, building material or refuse must be prohibited within riparian habitat;
- Dumping of materials must only take place at designated and properly managed areas;
- Make use of existing infrastructure such as roads as to minimise impacts;
- Construction activities altering the physical watercourse (excavations, etc.) must take place within the low flow period of the stream; and
- Water quality assessments must be conducted up and downstream of the Bot and Leeu rivers prior to construction and right after construction, in order to determine the effects of the construction phase and for future reference.

5.4.2 Operational phase

- Should any signs of erosion be found, remedial action such as backfilling, compaction and re-vegetation must be taken immediately to avoid exacerbation of the erosion;
- No stockpiling of any materials may take place adjacent to the river or wetlands;
- Ensure that all stockpiles are well managed and have measures to minimise the mobilisation of sediments such as the use of sand bags, hessian sheets, etc.;
- Erosion control measures must be implemented in areas sensitive to erosion and where erosion has already occurred such as edges of slopes, exposed soil etc. These measures include but are not limited to - the use of sand bags, hessian sheets, silt fences, retention or replacement of vegetation and geotextiles such as soil cells which are used in the protection of slopes;
- Do not allow surface water or storm water to be concentrated, or to flow down cut or fill slopes without erosion protection measures being in place;
- Any abstraction of water from rivers/wetlands for construction purposes must be approved by the Department of Water and Sanitation (DWS);

- Limit activities occurring within the in-stream area of channels;
- Regular inspection of the two slurry dam walls;
- It is crucial that the contamination of the surface waters through deleterious effluents and runoff water be avoided;
- Maintenance of stormwater drains must be undertaken as sensitively as possible to prevent adverse impacts to the environment and any watercourses;
- Quarterly water quality monitoring on the Bot and Leeu rivers must be conducted in accordance with a faecal coliform and *E coli* analysis for a period of two years and include regular inspections of pump station and pipeline operation;
- Any disturbed areas should be rehabilitated in line with the rehabilitation guidelines, this includes the clearing of alien vegetation, following the guidelines of a suitable alien invasive plant management plan;
- The site must be regularly monitored for re-growth of alien invasive species, and any new seedlings etc. eradicated using methods appropriate for the particular species, whether mechanical, chemical or biological;
- Pump stations will need to be fenced/secured to prevent unauthorized access by humans/wildlife which could cause damage to infrastructure and cause accidental malfunction and/or spillage of untreated waste water;
- The pump station will need to be placed within a suitably lined, impermeable bunded area with the capacity to hold untreated waste water in an emergency and provide for sufficient time for maintenance staff to address any faults/problems. This is to limit the risk of untreated waste material (sewage or sludge) overflowing in the event of any leakage or accidental spillage;
- Protect as much indigenous vegetation as possible; and
- Mitigation measures must be implemented with a suitable EMPr.

5.5 Risk Assessment

The risk assessment focussed on the construction phases which includes the expansion of the existing piggery unit and the proposed slurry dams and their respective operational phases as mentioned above.

During the construction phase, increased turbidity and sedimentation in the stream as well as altered flow patterns will occur. The machinery used has a risk of hydrocarbon spills into the channel. The construction phase calculated a low risk for the watercourses assessed.

There are impacts on the flow patterns to the stream as well as possibly increased nutrient levels from the waste materials entering the watercourse. The operational phase has an overall low risk impact rating due to the duration of the impacts.

This report highlights the findings for a one site survey, limiting the confidence for the risk assessment in **Table 15**.

Table 15: Significance ratings matrix for the impacts associated with the proposed slurry dams and existing piggery extension

No.	Phases	Activity	Aspect	Impact	Flow Regime	Physico & Chemical (Water Quality)	Habitat (Geomorph + Vegetation)	Biota	Severity	Spatial scale	Duration	Consequence	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Significance	Risk Rating	Confidence level
1	Construction phase	Dam wall and Piggery unit extension	Access routes for bridge construction	SEDIMENTATION AND EROSION	2	1	2	2	1,75	1	2	4,75	2	2	1	2	7	33,25	L	60
			Installation of road drainage																	
			Use of heavy machinery																	
			Bank trampling																	
2	Construction phase	Dam wall and Piggery unit extension	Increased runoff from hardened surfaces	WATER QUALITY AND POLLUTION	1	2	1	2	1,5	1	2	4,5	3	2	5	2	12	54	L	60
			Accidental spillages																	
			Surfacing seals																	
3	Construction phase	Dam wall and Piggery unit extension	Vegetation clearing	RIPARIAN VEGETATION	2	1	2	2	1,75	1	2	4,75	2	2	1	1	6	28,5	L	50
			Heavy machinery for dam wall construction																	
4	Operational phase	Dam wall and Piggery unit extension	Flow alterations	SEDIMENTATION AND EROSION	2	1	2	2	1,75	1	5	7,75	3	2	1	1	7	54,25	L	50
			Sedimentation and erosion																	
			Isolation of aquatic populations																	
			Increased grazing and bank trampling																	
5	Operational phase	Dam wall and Piggery unit extension	Eutrophication from dam	WATER QUALITY AND POLLUTION	1	2	1	2	1,5	1	5	7,5	3	2	1	1	7	52,5	L	70
			Bank trampling																	
			Irrigation runoff from crops																	
6	Operational phase	Dam wall and Piggery unit extension	Increased traffic	RIPARIAN VEGETATION	2	1	2	2	1,75	1	5	7,75	3	2	1	1	7	54,25	L	40
			Increased sedimentation and erosion																	

5.6 Wetland Buffer

The 'B' section channels were assessed using the Preliminary Guideline for the Determination of Buffer Zones for Rivers, Wetlands and Estuaries, 2014. Buffer zones outside the boundary of wetlands and riparian habitats are required to ensure that the ecotones between aquatic and terrestrial environments are conserved. These ecotones have a high ecological significance and have been shown to perform a wide range of functions, and on this basis, have been proposed as a standard measure to protect water resources and associated biodiversity (MacFarlane *et al.*, 2014). These functions include:

- Maintaining basic aquatic processes;
- Reducing impacts on water resources from upstream activities and adjoining land uses;
- Providing habitat for aquatic and semi-aquatic species (species with a biphasic life cycle);
- Providing habitat for terrestrial species; and
- A range of ancillary societal benefits.

The buffer tool aims to provide a method for determining appropriate buffer-widths for developments associated with wetlands, rivers or estuaries. This method takes into account a number of different factors in determining the buffer width including the impact of the proposed activity on the water resource, climatic factors and the sensitivity of the water resource

The calculated results indicate that a 25 m buffer is appropriate for the protection of the ecosystem services provided by the drainage channels and that 45 m was appropriate for the Bot River (**Figure 15**). Any further expansion of the piggery farm will occur outside of these recommended buffer zones.

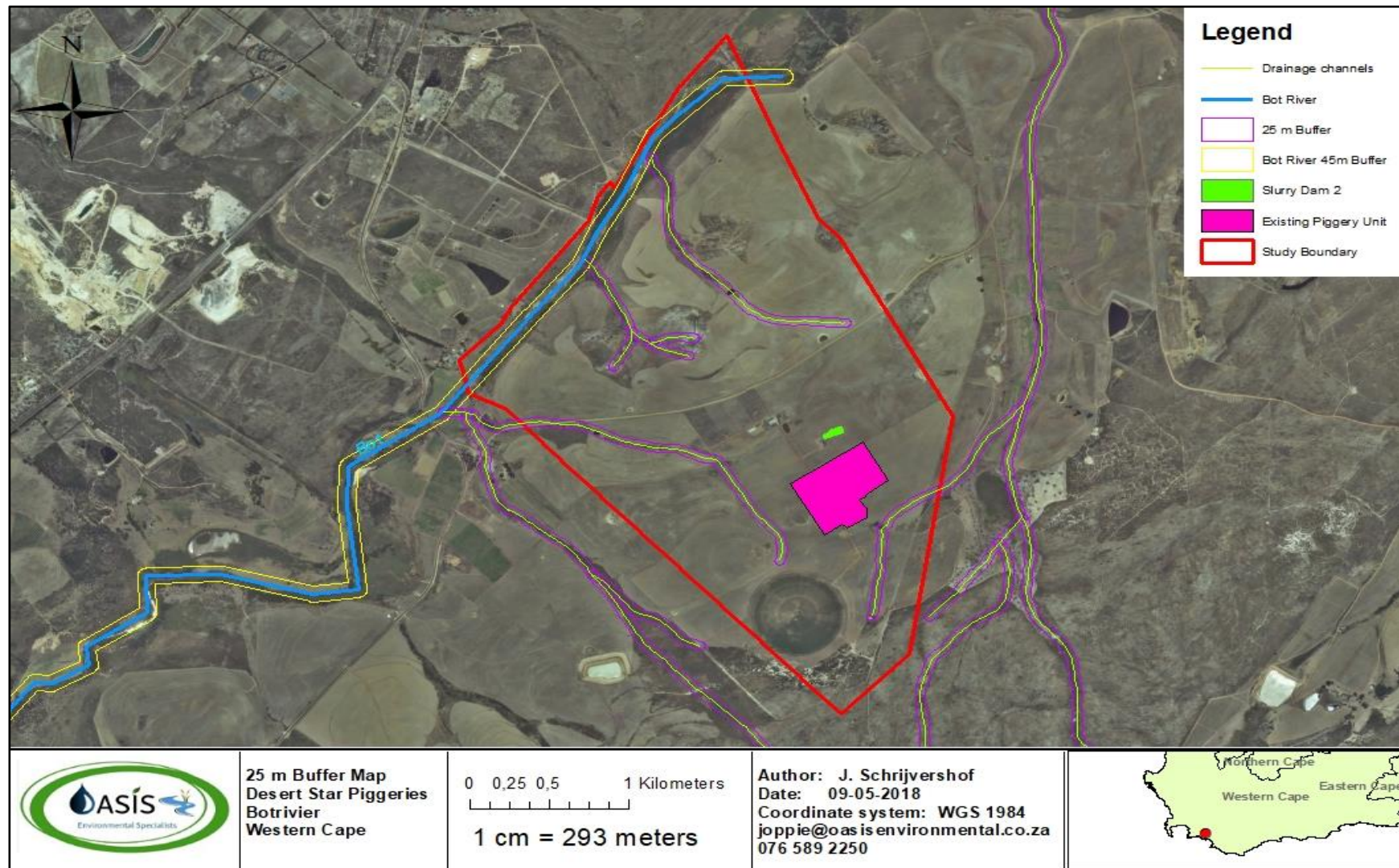


Figure 15: Farm 781 Caledon – Buffer map.

6 Conclusion & Recommendations

From the NFEPA database, valley bottom wetlands were identified within the project boundary. Based on the site delineation, these valley bottom wetlands were found to be the farm dams identified onsite and was characterised with the presence of two 'B' section channels within the 500 m buffer of the proposed activity. 'B' section channels are a subject to intermittent base flows and are considered hydrologically sensitive as they are associated with riparian habitats. These channels were found to be in a seriously modified (Category E) state due to the extensive landscape transformation with crop farming. A buffer of 25 m is recommended around the channels to ensure that the functioning is not further disturbed.

The farm boundaries falls within the Western Ruens Shale Renosterveld, Elim Ferricrete Fynbos and Overberg Sandstone Fynbos vegetation types and the Southern Folded Mountains Ecoregion. No plant species of conservation concern were identified during the site visit. Patches with alien invasive plant species were observed during the site visit near the Bot River and channel confluence.

A number of potential impacts relating to proliferation of alien invasive species, sedimentation and erosion and impacts on water quality are likely to occur as a result of the construction of the slurry dam and the operational piggery unit.

The significance of potential impacts on aquatic ecosystems within the area was rated as a low risk for the construction and operational phases. Key mitigation measures include:

- A 25 m Buffer on all drainage channels and 45 m for the Bot River;
- Water quality monitoring must take place quarterly during operation for the Bot and Leeu rivers;
- Water quality assessments must be undertaken prior and after construction;
- Active stormwater management must be implemented to stop silt and sediments from entering the aquatic system and smothering the habitat units;
- Regular slurry dam wall inspections;
- Disturbed soils and stockpiled soils must be protected from erosional features; and
- The prevention of alien invasive vegetation encroachment;

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GLOSSARY

Catchment: The area where water from atmospheric precipitation becomes concentrated and drains downslope into a river, lake or wetland. The term includes all land surface, streams, rivers and lakes between the source and where the water enters the ocean.

Delineation: Refers to the technique of establishing the boundary of a resource such as a wetland or riparian area.

Invasive alien species: Invasive alien species means any non-indigenous plant or animal species whose establishment and spread outside of its natural range threatens natural ecosystems, habitats or other species or has the potential to threaten ecosystems, habitats or other species.

Mitigate/Mitigation: Mitigating wetland impacts refers to reactive practical actions that minimise or reduce *in situ* wetland impacts. Examples of mitigation include “changes to the scale, design, location, siting, process, sequencing, phasing, and management and/or monitoring of the proposed activity, as well as restoration or rehabilitation of sites”. Mitigation actions can take place anywhere, as long as their effect is to reduce the effect on the site where change in ecological character is likely, or the values of the site are affected by those changes (Ramsar Convention, 2012).

Watercourse: Means a river or spring; a natural channel in which water flows regularly or intermittently; a wetland, lake or dam into which, or from which, water flows: und any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks (National Water Act, 1998).