Environmental Impact Assessment of proposed Boschendal Village, Boschendal Estate

February 2017

FINAL REPORT

Report compiled by: K. Snaddon,
The Freshwater Consulting Group, P O Box 43935, Scarborough, 7975

Submitted to: Doug Jeffery Environmental Consultants

Freshwater Consulting cc trading as **"The Freshwater Consulting Group" (FCG)**
Partners: E Day, J L Ewart-Smith, C D Snaddon, H F Dallas, D Ollis
Reg. No. 2007/064216/23

Table of Contents

TABLE OF CONTENTS **2**

1 INTRODUCTION **5**

1.1 Background and Approach **5**

1.2 Limitations **6**

1.3 Use of this Report **6**

1.4 Declaration of Independence **6**

1.5 Specialist Details **6**

2 DESCRIPTION OF THE AFFECTED AREA **7**

3 ASSESSMENT OF CONSERVATION IMPORTANCE OF THE AFFECTED FRESHWATER ECOSYSTEMS **13**

3.1 General sub-catchment information **13**

3.2 Present ecological status, ecological importance and sensitivity of the freshwater ecosystems **13**

3.2.1 Methods and results 13

4 LEGISLATION AND GUIDELINES GOVERNING THE CONSERVATION AND MANAGEMENT OF RIVERS AND WETLANDS **20**

4.1 National Environmental Management Act (Act 107 as amended by Act 62 of 2008) **20**

4.2 Environmental Impact Assessment regulations issued in terms of NEMA (originally promulgated as Regulation 385, 2006, with new legislation adopted in December 2014) **20**

4.3 Conservation of Agricultural Resources Act (Act 43 of 1983) **20**

4.4 Biodiversity Act **20**

4.5 Cape Nature Conservation Ordinance (Ordinance 19 of 1974; amended in 2000) **21**

4.6 National Water Act (1998) **21**

4.7 Western Cape Provincial Spatial Development Framework (Draft, 2013) **22**

4.8 Stellenbosch Municipality Spatial Development Framework **23**

5 DESCRIPTION OF PROPOSED DEVELOPMENT **24**

5.1 Proposed alternatives **24**

5.1.1 Alternative 1: No-go option 24
5.1.2 Alternative 2: Retirement village (2011) 24
5.1.3 Alternative 3: Rural Village, September 2014 25
5.1.4 Alternative 4: Rural Village, May 2015 26
5.1.5 Alternative 5a: Rural Village, October 2015 –Preferred alternative 27
5.1.6 Alternative 5b: Rural Village, October 2015 28
5.1.7 Alternative 5c: Rural Village, Preferred option, May 2016 29

5.2 Services **30**

5.2.1 Roads 30
5.2.2 Stormwater and sewage 30
5.2.3 Water and Electricity 33

6 DESCRIPTION OF PROBABLE IMPACTS AND MITIGATION MEASURES **36**

6.1.1 Layout 36

6.1.2 Construction phase ... 37
6.1.3 Operational Phase ... 39
6.1.4 Cumulative impacts ... 41

7 ENVIRONMENTAL IMPACT ASSESSMENT ... 42

7.1 Protocol for the assessment of impacts ... 42

7.2 Impact tables ... 42
7.2.1 Layout ... 42
7.2.2 Construction ... 44
7.2.3 Operational ... 47

8 CONCLUSIONS ... 50

9 REFERENCES ... 53

APPENDIX 1: RISK ASSESSMENT MATRIX ... 54

LIST OF FIGURES

Figure 2.1 Map of rivers (with buffers – blue polygons) and wetlands (bright green) done in 2007 during an EIA of the Boschendal Estate. The National Freshwater Ecosystem Priority Area (SANBI, Nel et al., 2011) dams and wetlands are shown in yellow. 7
Figure 2.2 Boschendal Village site (red boundary) with the wetlands (green polygons) and channels (blue lines) encountered on site during the field visit in January 2015. A green arrow shows the wet area associated with a broken water pipe. The Dwars River lies to the east of the site. 9
Figure 2.3 Aerial photograph of the site taken in 1938. The arrows show the transition between the gentle slopes and the river floodplain, where several seep wetlands have formed. 10
Figure 2.4 Proposed routes for the bulk water and sewer pipes required for the development, showing the location of natural watercourses (blue arrows) and drainage ditches (green arrows) along the routes. 11
Figure 5.1 Site Development Plan: Alternative 2 (DMP 2011) 25
Figure 5.2 Alternative 3 (Philip Briel, 2014). 26
Figure 5.3 Alternative 4 (Philip Briel, 2015). 27
Figure 5.4 Alternative 5a –Preferred option. (source: Philip Briel Architects). 28
Figure 5.5 Alternative 5b. 29
Figure 5.6 Alternative 5c. 30
Figure 5.7 Stormwater infrastructure on the site, showing all proposed channels. 31
Figure 5.8 Stormwater infrastructure, showing the proposed stormwater pond, and detail regarding the outlet. This diagram also shows the extent of fill area required for Alternatives 4 and 5a. 32
Figure 5.9 Schematic of proposed sewage pump station next to the Dwars River bridge. 32
Figure 5.10 Overview of the pipeline routes for both the water supply and sewer pipelines. 33
Figure 5.11 Typical pipe crossing over watercourses and ditches. 34
Figure 5.12 Aerial photograph with the site boundary (red line) and some of the services (see legend). 34

LIST OF TABLES

Table 3.1 Present Ecological State categories (adapted from Kleynhans, 1996). 15
Table 3.2 Ecological importance and sensitivity categories for rivers. 16
Table 3.3 Rating table used to rate ecological importance and sensitivity (EIS) (Rountree et al., 2013). 17
Table 3.4 Ecological Importance and Sensitivity Categories for Wetlands (Rountree et al., 2013). 18
Table 3.5 Results of the assessment of PES of the four wetlands on the Boschendal Village site. 18
Table 3.6 Results of the EIS assessment for wetlands on Boschendal Village project site. Scores for each component are from 0 (low) to 4 (high). The scores for hydrological/functional importance and direct human benefits come from the assessments using WET-Ecoservices. 19
Table 7.1 Criteria used for the assessment of impacts associated with the proposed Boschendal development. 42

1 Introduction

1.1 Background and Approach

The Freshwater Consulting Group (FCG) was approached by Doug Jeffery Environmental Consultants to provide freshwater ecological input to an Environmental Impact Assessment (EIA) of the proposed Boschendal Village on Boschendal Estate. The proposed development is located at the intersection of the R45 and R310, Stellenbosch Municipality, affecting Portions 7 and 10 of Farm 1674, Boschendal. Currently, the land is mainly open, uncultivated land, with some buildings scattered across the site.

The land uses would comprise a mix of land-uses made up of the following:

- Residential development at various densities;
- Small artisan and deli shops, a farmers market, other specialty shops that produce and sell local products;
- Commercial and office development, and
- Tourism-related development including accommodation.

A stormwater drainage system would be constructed to accommodate the external flows presently crossing the site in addition to runoff generated by the proposed development. Sewage pipes and a sewage pump station will be installed. Water supply pipelines, a pump station and storage reservoir will be constructed for potable water. It is envisaged that no development will occur within 32 m of any watercourses, however stormwater will be discharged into a natural watercourse, and pipelines will cross over a watercourse, thus requiring environmental and water use authorisation.

Specifically, the terms of reference for the work were as follows:

<u>PHASE 1: Constraints analysis and baseline assessment (scoping)</u>

- <u>Determine the location and extent of any surface freshwater ecosystems on the site</u>. A site visit will allow for a rough delineation (according the DWAF (2005) guidelines) of any surface freshwater ecosystems potentially affected by the development. These ecosystems will be mapped using a hand-held GPS. A suitable buffer will be proposed around the freshwater ecosystems, if relevant.
- <u>Assess the condition and ecological importance and sensitivity of the freshwater ecosystems</u>: the accepted protocols for the assessment of ecological importance and sensitivity (EIS) and present ecological state (PES) will be used in order to undertake a rough assessment of the freshwater ecosystems encountered on the site. The collection of primary data – algae, invertebrates – may be necessary for completing the assessment. Background information on the ecosystems and the surrounding area (e.g. FEPA maps, etc) will be consulted, where available.
- <u>Write a baseline report</u>: the results of the site visit and the assessments described above will be reported, in addition to any constraints that the freshwater ecosystems on the site may place on the proposed development alternatives. The report will highlight concerns and the mitigation measures required, and will provide specific management and monitoring requirements, to be used as the basis of conditions for the Environmental Authorisation (should it be granted), and subsequent Construction and Operational Environmental Management Plans.

PHASE 2: Environmental Impact Assessment

- Describe and assess the impacts associated with the pre-construction, construction and operational phases of proposed development. The impacts identified in the baseline study will be described and assessed according to the EIA regulations, and according to the criteria provided in your ToR. Cumulative impacts will be taken into account.
- Recommend mitigation measures, to reduce the severity of the negative impacts and to enhance the positive impacts.
- Produce an EI report, which will include the baseline report and the impact assessment. The information requirements for applying for a Water Use Licence Application or General Authorisation under the Water Act will be addressed, as any development affecting watercourses or wetlands would require such an authorisation or registration. This information can be used for the application process, if this is relevant.

1.2 Limitations

Mapping was done with a hand-held GPS in order to save time and costs. Accuracy is estimated as being approximately 2-3m. Delineation of wetlands was done using the indicators described in the DWAF (2005) guidelines for delineation of wetlands and riparian areas. None of the wetlands were sufficiently inundated to collect primary data, such as water quality, invertebrates and algae, for a more detailed assessment of present ecological state. However, the visual assessment done for this baseline assessment is considered sufficient for the purposes of this project.

1.3 Use of this Report

This report reflects the professional opinions of its author. It is the policy of FCG that the full and unedited contents of this report should be presented to the client, and that any summary of the findings should only be produced in consultation with the author.

1.4 Declaration of Independence

This is to confirm that Kate Snaddon, the specialist consultant who is responsible for undertaking this study and preparing this environmental impact assessment report, is independent, and has no vested interests, financial or otherwise, in the development under consideration.

1.5 Specialist Details

The author of this report is an independent specialist consultant, with 21 years of experience in the field of freshwater ecology, registered with the South African Council for Natural Scientific Professions (registration number 400225/06).

2 Description of the affected area

The project site is located on the left bank of the Dwars River, with the boundary of the site coming, at its closest, to within approximately 200 m of the river. The Boschendal Estate was the subject of an earlier assessment in 2007 (Snaddon, 2007), during an environmental impact assessment of proposed development of the Estate. The watercourses and wetlands were mapped on both sides of the Helshoogte Road, resulting in the map presented in Figure 2.1.

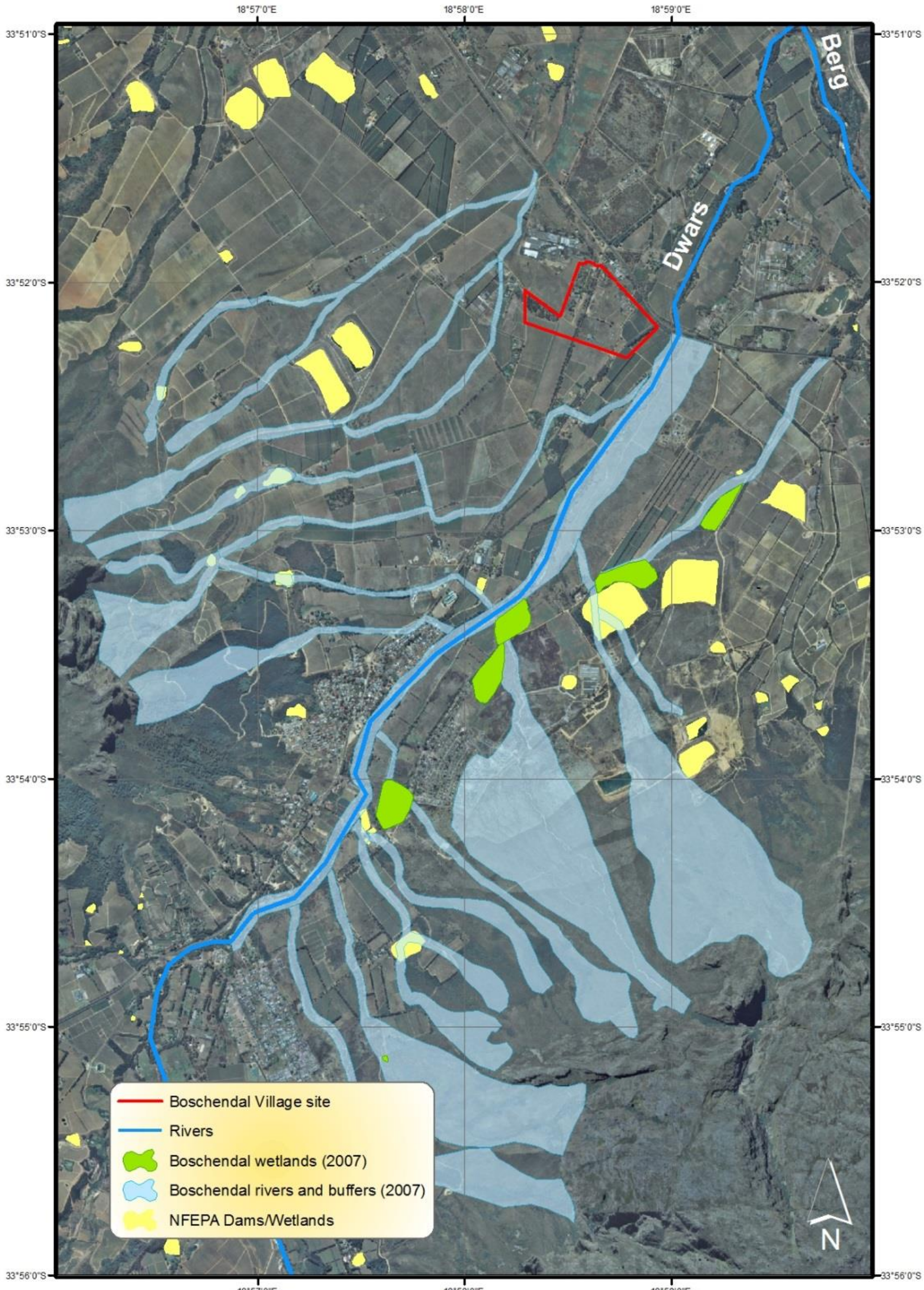

Figure 2.1 Map of rivers (with buffers – blue polygons) and wetlands (bright green) done in 2007 during an EIA of the Boschendal Estate. The National Freshwater Ecosystem Priority Area (SANBI, Nel *et al.,* 2011) dams and wetlands are shown in yellow.

Most of the site falls within the ecoregion known as the south western coastal belt, while a small portion of the site in the south-western corner lies within the southern folded mountains (from Kleynhans *et al.*, 2005). The quaternary catchment is G10C in the Berg River Water Management Area. The site spans two sub-quaternary catchments.

The dominant freshwater ecosystem within the study area is the Dwars River, an important perennial tributary of the Berg River. This river is a foothill, cobble-bed system typical of the Fynbos Biome – instream habitat is typically riffle-run sequences with some pools and marginal vegetation. Water quality of the Dwars River is impacted by runoff from Pniel, farming activities (e.g. severe impacts at times as a result of runoff from the Boschendal piggery) and limited industrial activity in the area. During high flows, the Dwars River has high levels of phosphorus and total suspended solids, due to surface runoff from agricultural areas (e.g. Day, 2004; Snaddon, 2004).

The underlying geology of the Dwars River Valley is dominated by granites of the Stellenbosch Pluton of the Cape Granite Suite, and the surrounding mountains comprise quartzitic Table Mountain Group sandstones (Parsons, 2010). The bed of the Dwars River is made up of quartzite cobbles and boulders that have been carried down the valley by the river and its tributaries.

Historically, the vegetation on the site would have been Boland Granite Fynbos (Mucina *et al.,* 2007; updated vegetation map, 2009). This is an endangered vegetation type found in the Dwars River Valley and on the surrounding mid-slopes (Rebelo *et al*., 2006). The lower, eastern boundary of the site would have been Swartland Alluvium Fynbos, which is typical of riverine valley floors and floodplains.

Most of the site has been heavily disturbed through agricultural activities (primarily orchards, now pears), road construction and use, housing, and small-scale industrial operations. Very little of the original vegetation remains on the site (see also Helme, 2015). There are several agricultural drains crossing the site, serving to channel surface water away from buildings and fields (see Figure 2.2). Four wetlands were noted on site during the field visit. In addition, a wet area has been created through water leaking from a broken water pipe. The wetlands are associated with agricultural drains, roads and railway lines but most of them are likely to be remnants of more extensive wetland areas, which have been partially impacted by the surrounding activities.

Wetlands 1 and 2 are located near the south-eastern corner of the site, and are probably two parts of the same wetland, on either side of a dirt road bisecting this area (Figure 2.2). The wetlands are both mono-specific stands of riverbed grass, *Pennisetum macrourum*. This species is an indicator of temporary to seasonal wetness, and is thus a wetland indicator. The soils in this wetland are sandy in texture and light grey in colour (hue of 10YR, a value of 7 and a chroma of 1 on the Munsell soil colour chart, thus indicating signs of wetness in the soil horizon) with some signs of a ferricrete base. A proportion of the Western Cape soils lack the usual signs of wetness displayed throughout South Africa, as recommended in the DWS guidelines for wetland and riparian zone delineation (DWAF, 2005). These difficult soils are typically sandy, and of low chroma, or colour (Job, 2009). The soils on this site fit this description (chroma of 1 – see above). In the absence of clear wetness indicators in the soil, the hydrology and vegetation of the area may present better indicators of wetland presence. In this case, the presence of *P. macrourum* confirms temporary to seasonal wetness.

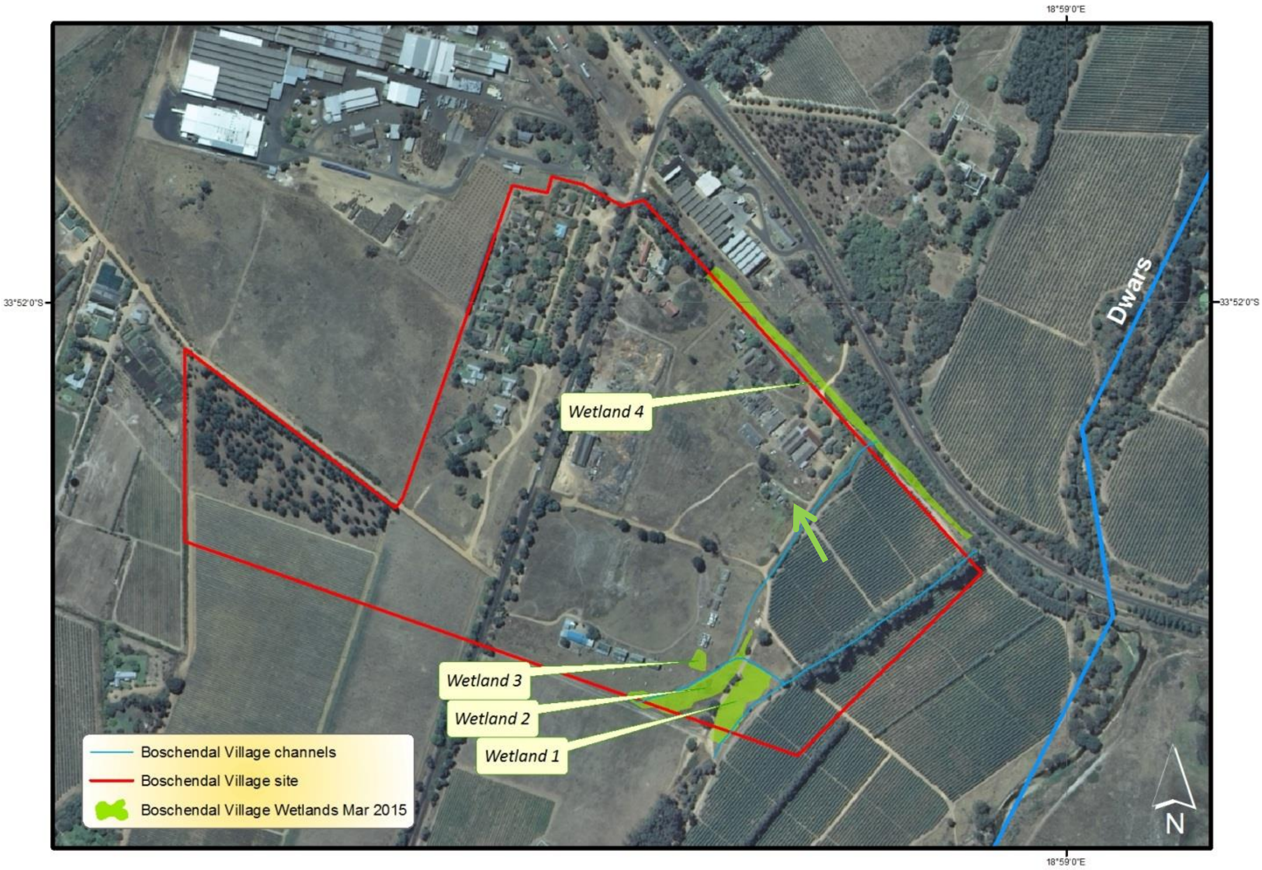

Figure 2.2 Boschendal Village site (red boundary) with the wetlands (green polygons) and channels (blue lines) encountered on site during the field visit in January 2015. A green arrow shows the wet area associated with a broken water pipe. The Dwars River lies to the east of the site.

Wetland 3 is a small, isolated patch of *P. macrourum*, with similar soil conditions to Wetlands 1 and 2. This wetland occupies a slight indentation in the ground. Due to its isolation from an obvious surface water source and from wetlands 1 and 2 and its small size, it is difficult to ascertain whether this is a naturally occurring wetland, or one that was created as a result of excavations in the area.

Wetland 4 is a linear wetland that is adjacent to the railway line. While this area may always have been seasonal wetland, the shape and location of the wetland area is probably influenced by the obstruction to subsurface and surface flow presented by the railway line, and the surrounding buildings. This wetland is also dominated by *P. macrourum.*

The **artificially wet area** in the middle of the site is a permanently wet area, close to a few houses. This wetland has been artificially created from a burst and leaking water pipe lying adjacent to the buildings. Vehicles crossing over the pipe have compacted the pipe, and water was been leaking here for some time, creating a perennially wet area. The patch is dominated by the bracken, *Pteridium aquilinum*, which is an indigenous but invasive species, growing in seasonally wet, sandy , well-drained soils. This artificially wet area is not considered to be of any ecological importance, and would drain away once the pipe is mended or removed.

Wetlands 1, 2 and 4 are hillslope seeps[1] and wetland 3 an isolated depression (sensu Ollis *et al*., 2013). Given the soil type observed on site and the hydrogeomorphic wetland type noted here, it is most likely that the hillslope seep wetlands are fed naturally primarily by subsurface (i.e. interflow) water and groundwater, rather than surface water. The localised water table is higher in winter, pushing water to the surface and creating / sustaining seepage wetlands. This water daylights (surfaces) where there is a change in topography – this occurs along the outer edge of the Dwars River floodplain, i.e. the gentle surrounding slopes meet the flatter floodplain, and the subsurface water surfaces. This is partially evident from a historical aerial photograph taken in 1938 (Figure 2.3). Wetland 3 probably relies on rainfall as its water source.

Surface water draining into and through the wetlands by virtue of the agricultural channels will add to the subsurface water supply, but this is unlikely to sustain the wetlands through the dry summer months. The sandy soils are well-drained and dispersive, with considerable absorptive capacity, leading to the lack of natural surface channels, and occurrence of seep wetlands.

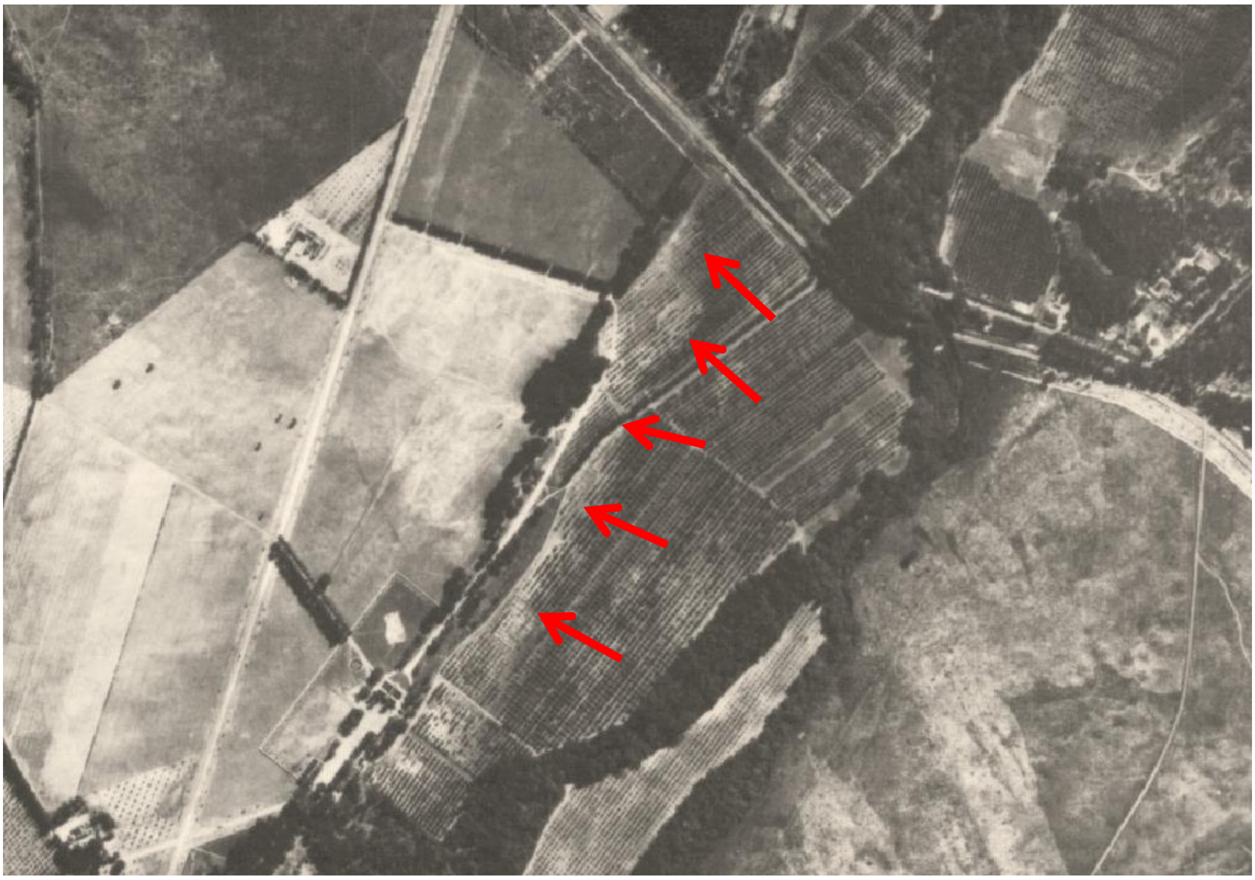

Figure 2.3 Aerial photograph of the site taken in 1938. The arrows show the transition between the gentle slopes and the river floodplain, where several seep wetlands have formed.

Five small watercourses and a number of agricultural and stormwater ditches will be impacted by the proposed bulk water and sewer pipelines that will run from Pniel to the Village site (Figure 2.4). Some of these were assessed previously as part of the 2007 Boschendal Estate EIA (Snaddon, 2007), and the others were assessed in September 2016.

[1] **seep**: a wetland area located on gently to steeply sloping land and dominated by the colluvial (i.e. gravity-driven), unidirectional movement of water and material down-slope. Seeps are often located on the side-slopes of a valley but they do not, typically, extend onto a valley floor. Water inputs are primarily via subsurface flows from an up-slope direction. (from Ollis *et al*., 2013).

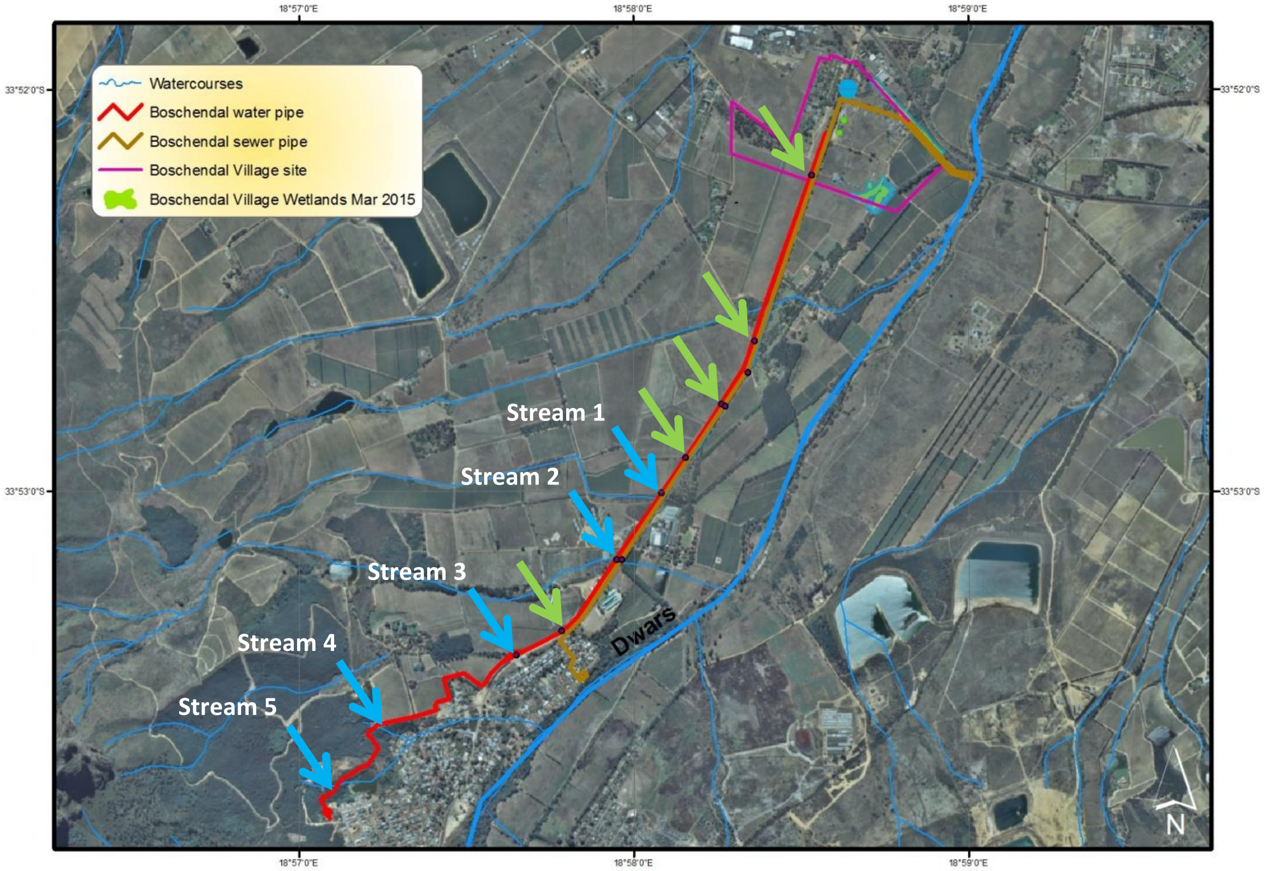

Figure 2.4 Proposed routes for the bulk water and sewer pipes required for the development, showing the location of natural watercourses (blue arrows) and drainage ditches (green arrows) along the routes.

The natural channels are all fairly modified from their natural state, due to the proximity of roads, houses, agricultural activities and infestations of acacias. Streams 1 - 3 have been channelled to a certain extent around agricultural fields and in one case (Stream 2 on Figure 2.4), around a sports field. Stream 5 flows into an impoundment above Pniel, and Stream 4 flows for a short distance above Pniel, disappearing into the village below (probably into pipes, but this was not confirmed). The riparian vegetation is dominated by kikuyu grass, with some reeds (*Phragmites australis*), bulrush (*Typha capensis*) sedges, grasses (mainly *Pennisetum macrourum*) and arum lilies. *Seersia angustifolia* (willow karee) also occurs in clumps in the riparian zone (Photo 1). The channels are generally between 2 and 5 m wide, with gently sloping banks and sandy beds. Where these watercourses cross under the Helshoogte Road, they are carried in pipes under the road, continuing along either natural or artificial channels on the southern side of the road.

Photo 1 Riparian vegetation on the banks of one of the natural watercourses that would be crossed by the water supply pipeline. The trees are *Searsia angustifolia* (willow karee).

3 Assessment of conservation importance of the affected freshwater ecosystems

3.1 General sub-catchment information

According to the National Freshwater Ecosystem Priority Area (NFEPA) project maps, the Dwars River sub-catchment in which the project site lies is classified as a Phase 2 FEPA. Phase 2 FEPAs were identified by the NFEPA project as moderately modified rivers (C ecological category), only in cases where it was not possible to meet biodiversity targets for river ecosystems in rivers that were still in good condition (A or B ecological category). The condition of these Phase 2 FEPAs should not be degraded further, as they may in future be considered for rehabilitation once FEPAs in good condition (A or B ecological category) are considered fully rehabilitated and well managed.

Neither of the sub-quaternary river reaches (i.e. river reaches lying in the two sub-catchments in which the project site lies) affected by the proposed development is a known location of threatened indigenous fish species.

A map of critical biodiversity areas (CBAs) was developed for the Drakenstein Municipality during the Western Cape Biodiversity Framework project (2010, updated in 2014). This map identifies the Dwars River as an Ecological Support Area – areas important as support for CBAs, and where ecological processes must be maintained. No other significant aquatic CBAs or ESAs are located on or near the site. There are no protected areas on or near the site.

In summary based on the above, the two sub-quaternary catchments across which the project site lies are not of significant conservation importance as a whole, however, activities taking place in the Dwars River sub-catchment should not lead to deterioration in the condition or ecological functioning of the Dwars River.

3.2 Present ecological status, ecological importance and sensitivity of the freshwater ecosystems

3.2.1 Methods and results

An assessment of the conservation importance or status of a specific freshwater ecosystem combines assessments of both the current ecological status of the ecosystem and its perceived ecological importance and sensitivity. The *ecological status or integrity* of an ecosystem is its ability to support and maintain a balanced, integrated composition of physico-chemical and habitat characteristics, as well as biotic components on temporal and spatial scales that are comparable to the natural characteristics of ecosystems of the region. The integrity of a system is directly influenced by its current state, and how much the system has been altered from the reference or unimpacted condition.

The *ecological importance* (EI) of a river or wetland is an expression of its importance to the maintenance of ecological diversity (i.e. both species and habitat diversity) and functioning on local and wider scales. *Ecological sensitivity* (or fragility) (ES) 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). Specifically, the system's sensitivity to changes in flow, physico-chemical and geomorphological characteristics are considered.

Both abiotic and biotic components of the system are taken into consideration in an assessment of ecological importance and sensitivity (EIS). It is strongly biased towards the potential importance and sensitivity of a particular section of a freshwater ecosystem, as it would be expected under *unimpaired* conditions.

Assessments of both the Dwars River and the three on site wetlands were completed.

3.2.1.1 Dwars River and off-site watercourses

The Department of Water and Sanitation's (DWS) Resource Directed Measures (RDM) approach provides methods for the assessment of ecological integrity and ecological importance and sensitivity for rivers, in the context of the determination of the ecological management class as part of the Reserve Determination procedure (DWAF, 1999). This procedure can be followed at different levels of detail – desktop, rapid, intermediate and comprehensive. The desktop approach was followed for the Dwars River and the off-site watercourses (that would be affected by the pipelines) due to the timeframe of the project. A national desktop assessment of the PES and EIS of river reaches was recently completed by DWS (DWS, 2014), and this information is presented here for the Dwars River.

The desktop assessment of DWS is also compared against an assessment of PES and EIS done by Snaddon (2010) during an EIA of the upgrade to the Pniel WWTW roughly 4 km upstream of the site, for comparative purposes.

3.2.1.1.1 Present Ecological Status

The criteria considered indicative of the Present Ecological Status (PES) of a sub-quaternary river reach (SQR) are selected on the basis that anthropogenic modification of riverine characteristics can generally be regarded as the primary cause of degradation of the integrity of that reach. Certain modifications will have a detrimental impact on the habitat integrity or status of a river, the extent of that impact being dependent on their severity.

The PES assessment of DWS is based on the assessment of existing impacts on two components of the river - the **riparian** zone and the **instream** habitat. Assessments are made separately for both components, but data for the riparian zone are interpreted primarily in terms of their potential impact on the instream component. Criteria within each component are pre-weighted according to the importance of each, and each criterion is scored between 0 and 25, with six descriptive categories ranging from 0 (no impact), 1 to 5 (small impact), 6 to 10 (moderate impact), 11 to 15 (large impact), 16 to 20 (serious impact) and 21 to 25 (critical impact). The total scores for the instream and riparian zone components were used to place the site in a habitat integrity category (A – E/F) for both components. A full description of the method can be found in DWAF's RDM document (DWAF, 1999).

Table 3.1 Present Ecological State categories (adapted from Kleynhans, 1996).

CATEGORY	DESCRIPTION
A	Unmodified, natural.
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.
C	Moderately modified. A loss and change of natural habitat and biota have occurred but the basic ecosystem functions are still predominantly unchanged.
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.
E	The loss of natural habitat, biota and basic ecosystem functions is extensive.
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.

3.2.1.1.2 Ecological Importance and Sensitivity

The DWA-recommended method for the determination of the Ecological Importance and Sensitivity of a river reach considers the following ecological aspects:

- Rare and endangered instream and riparian biota;
- Unique instream and riparian biota;
- Intolerant instream and riparian biota;
- Species richness, both riparian and instream;
- Diversity of habitat types or features;
- Refuge value of habitat types;
- Sensitivity of habitat to flow changes;
- Sensitivity to flow related water quality changes;
- Sensitivity to water quality changes in terms of alkalinity;
- Sensitivity to water quality changes in terms of hardness;
- Migration route/corridor for instream and riparian biota, and
- Presence of Protected Areas and conservation areas.

Each criterion is scored between 1 and 5, and the medians of these scores are calculated to derive the EIS category (Table 3.2).

Table 3.2 Ecological importance and sensitivity categories for rivers.

Ecological Importance and Sensitivity Categories	General Description
Very high (score >3 and ≤4)	Reaches or rivers that are considered to be unique on a national or even international level based on unique biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are usually very sensitive to channel / bed modifications and have no or only a small capacity for use.
High (score >2 and ≤3)	Reaches or rivers that are considered to be unique on a national scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) may be sensitive to channel / bed modifications but in some cases, may have a substantial capacity for use.
Moderate (score >1 and ≤2)	Reaches or rivers that are considered to be unique on a provincial or local scale due to biodiversity (habitat diversity, species diversity, unique species, rare and endangered species). These rivers (in terms of biota and habitat) are usually not very sensitive to channel / bed modifications and often have a substantial capacity for use.
Low/marginal (score >0 and ≤1)	Reaches or rivers that are not unique at any scale. These rivers (in terms of biota and habitat) are generally not very sensitive to channel / bed modifications and usually have a substantial capacity for use.

3.2.1.1.3 Results of PES and EIS assessments of the Dwars River and off-site watercourses

The DWS desktop PES for the SQR of the Dwars River flowing past the site is category C, i.e. moderately modified. Snaddon's (2010) assessment of the Dwars River flowing past the Pniel WWTW yielded a similar result, with a category C for instream PES and category D for riparian vegetation.

The following anthropogenic impacts were recorded as impacting on the condition of the reaches of the Dwars River flowing past the Boschendal Village site:

- Encroachment of cultivated lands and roads close to and into the riparian zone of the river (i.e. within the 1:100 year floodline);
- Construction of river crossings over the river;
- Alien invasion of the riparian zone, with subsequent erosion and steepening of banks;
- Discharge of treated effluent from the Pniel Waste Water Treatment Works, and
- Diffuse discharge of irrigation return flows into the river, carrying fertilizers, herbicides and pesticides into the river.

The EI for the Dwars River was calculated as being high, and the ES very high. These results were based on the following:

- The Dwars River is likely to be home to at least three species of indigenous fish (note: this is not the same as the NFEPA fish sanctuaries, which are **known** locations of fish populations), and a diversity of riverine macroinvertebrates (approximately 50 taxa estimated to occur within the river reach);
- The value of the river as a corridor as refuge for and the movement of fauna and flora within a highly cultivated environment, and
- The sensitivity of the system to changes in water quality and quantity, due to the relatively undisturbed state of the instream habitat and to the relatively good water quality.

The *default ecological category* for this stretch of river, which is based on a combination of the PES, EI and ES results, is a category A. This is essentially the desired state of the river, and a goal for river management. While it may seem unlikely that this category is attainable, it emphasises the recommendation that **no**

activities in and around the sub-catchment should lead to a deterioration in the condition of the river, as stated above in Section 3.1.

The results of the assessment of PES and EIS for the off-site watercourses are as follows:

- Stream 1: PES is B/C, and EIS is moderate;
- Stream 2: PES is D, and EIS is moderate;
- Stream 3: PES is B/C, and EIS is moderate;
- Stream 4: PES is C, and EIS is low to moderate, and
- Stream 5: PES is B/C, and EIS is moderate.

3.2.1.2 On site wetlands

3.2.1.2.1 Present Ecological Status

The Level 1 WET-Health assessment methodology was developed for the rapid assessment of the PES of the hydrology, geomorphology and vegetation of wetlands. The method is based on the hydrogeomorphic approach to wetland classification, providing a PES score for each HGM unit within each of the three modules, and a combined score for each HGM unit. The score provides a quantitative measure of the extent, magnitude and intensity of deviation from the reference condition. The score places the wetland in a wetland health category, A – F, as for rivers explained above (Table 3.1).

3.2.1.2.2 Ecological Importance and Sensitivity

The importance of each wetland was assessed by considering the range of goods and services identified in the Wet-Ecoservices tool (Kotze *et al.*, 2008). The outcomes of the Wet-Ecoservices assessment were then used to inform an assessment of the overall importance and sensitivity of the wetland using the Wetland Ecological Importance and Sensitivity (EIS) assessment tool of Rountree *et al*. (2013). The tool includes an assessment of three suites of importance criteria, namely:

- Traditional ecological importance and sensitivity (biodiversity support, landscape scale importance, and the sensitivity of the wetland to change);
- Hydrological and functional importance (water quality, flood attenuation and sediment trapping ecosystem services that the wetland may provide), and
- Human benefits (subsistence and cultural use of the wetland).

Each component was rated, according to the criteria in Table 3.3, below.

Table 3.3 Rating table used to rate ecological importance and sensitivity (EIS) (Rountree *et al.*, 2013).

Rating	Explanation
None, Rating = 0	Rarely sensitive to changes in water quality/hydrological regime
Low, Rating =1	One or a few elements sensitive to changes in water quality/hydrological regime
Moderate, Rating =2	Some elements sensitive to changes in water quality/hydrological regime
High, Rating =3	Many elements sensitive to changes in water quality/ hydrological regime
Very high, Rating =4	Very many elements sensitive to changes in water quality/ hydrological regime

The maximum score for each suite of importance criteria was taken to be the overall EIS category for the wetland, as described in Table 3.4

Table 3.4 Ecological Importance and Sensitivity Categories for Wetlands (Rountree *et al.*, 2013).

Ecological Importance and Sensitivity Categories	Range of EIS scores
Very high: Wetlands that are considered ecologically important and sensitive on a **national or even international** level. The biodiversity of these systems 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
High: Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these systems 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
Moderate: Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these systems 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
Low/marginal: Wetlands that are not ecologically important and sensitive at any scale. The biodiversity of these systems 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

3.2.1.2.3 Results of PES and EIS assessments of wetlands

The four wetlands located on the project site are similar in terms of their vegetation and soils (see Section 2). Their overall condition varies, however, mostly due to variations in the impacts associated with altered hydrology and geomorphology. This is mainly due to:

- Presence of channels draining into and out of the wetlands, which alter surface hydrology;
- Presence of roads, a railway line, berms, and other areas of infilling, which are obstacles to the flow of surface and subsurface water, leading to changes in the way water accumulates on the surface, and thus the extent and seasonality of the wetlands.

The intensity of these impacts vary between the wetlands, becoming more intense from wetland 1 to wetland 4 (Table 3.5).

Table 3.5 Results of the assessment of PES of the four wetlands on the Boschendal Village site.

<table>
<tr><th rowspan="2">Wetland</th><th rowspan="2">Area (ha)</th><th colspan="2">Hydrology</th><th colspan="2">Geomorphology</th><th colspan="2">Vegetation</th><th rowspan="2">Overall PES for wetland</th></tr>
<tr><th>Wetland Impact Score</th><th>PES category</th><th>Wetland Impact Score</th><th>PES category</th><th>Wetland Impact Score</th><th>PES category</th></tr>
<tr><td>Wetland 1</td><td>0.31</td><td>6.0</td><td>E</td><td>1.6</td><td>B</td><td>3.0</td><td>C</td><td>C</td></tr>
<tr><td>Wetland 2</td><td>0.34</td><td>7.0</td><td>E</td><td>1.8</td><td>B</td><td>3.0</td><td>C</td><td>D</td></tr>
<tr><td>Wetland 3</td><td>0.04</td><td>7.5</td><td>E</td><td>2.0</td><td>C</td><td>3.0</td><td>C</td><td>D</td></tr>
<tr><td>Wetland 4</td><td>0.51</td><td>9.5</td><td>F</td><td>3.2</td><td>C</td><td>4.0</td><td>D</td><td>E</td></tr>
</table>

In terms of ecological importance and sensitivity, all of the wetlands provide some wetland habitat, even if this is limited in diversity. Wetlands 1 and 2 together provide the least disturbed habitat, and thus may be important for feeding or breeding of some faunal species. However, their small size limits this benefit.

Wetland 3 is isolated and of very limited ecological value – this wetland may have been artificially created. Wetland 4 provides important stormwater management services currently, and this service could be improved within the proposed development footprint.

One of the important values of the wetlands on the site is their aesthetic value. The wetlands could provide open spaces within the development, which would have the added value of providing wetland habitat to the local fauna and flora. Rehabilitation of these wetlands would further enhance their value.

The results of the assessment of EIS of the wetlands are provided in Table 3.6.

Table 3.6 Results of the EIS assessment for wetlands on Boschendal Village project site. Scores for each component are from 0 (low) to 4 (high). The scores for hydrological/functional importance and direct human benefits come from the assessments using WET-Ecoservices.

Ecological Importance	Wetland 1	Wetland 2	Wetland 3	Wetland 4
Biodiversity support	**1.00**	**1.00**	**1.00**	**1.00**
Presence of Red Data species	**2.00**	**2.00**	**2.00**	**2.00**
Populations of unique species	-	-	-	-
Migration/breeding/feeding sites	**1.00**	**1.00**	**1.00**	**1.00**
Landscape scale	**1.40**	**1.40**	**1.20**	**1.40**
Protection status of the wetland	-	-	-	-
Protection status of the vegetation type	**3.00**	**3.00**	**3.00**	**3.00**
Regional context of the ecological integrity	**2.00**	**2.00**	**1.00**	**2.00**
Size and rarity of the wetland type present	**1.00**	**1.00**	**1.00**	**1.00**
Diversity of habitat types	**1.00**	**1.00**	**1.00**	**1.00**
Sensitivity of the wetland	**2.00**	**2.00**	**1.00**	**2.00**
Sensitivity to changes in floods	1.00	1.00	1.00	1.00
Sensitivity to changes in low flows/dry season	3.00	3.00	100	3.00
Sensitivity to changes in water quality	2.00	2.00	1.00	2.00
ECOLOGICAL IMPORTANCE & SENSITIVITY	**2.00**	**2.00**	**1.20**	**2.00**
HYDROLOGICAL/FUNCTIONAL IMPORTANCE	**1.70**	**1.46**	**1.61**	**1.54**
DIRECT HUMAN BENEFITS	**0.47**	**0.47**	**0.39**	**0.48**

All of the wetlands scored similarly for biodiversity support, landscape scale and sensitivity (see Table 3.6). Wetland 1 scored highest in terms of hydrological/functional importance, primarily because of its condition (PES higher than the other three wetlands). Wetland 4 has the highest direct human benefit score, as it currently performs stormwater management services.

Overall, the wetlands are considered to be of **moderate** importance and sensitivity, with wetland 3 achieving a lower score, due to its small size and probably anthropogenic origin.

4 Legislation and guidelines governing the conservation and management of rivers and wetlands

4.1 National Environmental Management Act (Act 107 as amended by Act 62 of 2008)

The National Environmental Management Act of 2008 (NEMA), outlines measures that…."prevent pollution and ecological degradation; promote conservation; and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development."

Of particular relevance to this assessment is Chapter 1(4r), which states that sensitive, vulnerable, highly dynamic or stressed ecosystems, such as coastal shores, estuaries, wetlands, and similar systems require specific attention in management and planning procedures, especially where they are subject to significant human resource usage and development pressure.

Section 24 of NEMA requires that the potential impact on the environment, socio-economic conditions and cultural heritage of activities that require authorisation or permission by law, must be considered, investigated and assessed prior to implementation, and reported to the relevant regulatory authority.

4.2 Environmental Impact Assessment regulations issued in terms of NEMA (originally promulgated as Regulation 385, 2006, with new legislation adopted in December 2014)

These regulations identify activities deemed to have a potentially detrimental effect on natural ecosystems, including aquatic ecosystems, and outline the requirements and timeframe for approval of development applications. Different sorts of activities are listed as environmental triggers that determine different levels of impact assessment and planning required. The regulations detail the procedure to be followed for a basic or full environmental impact assessment.

4.3 Conservation of Agricultural Resources Act (Act 43 of 1983)

Key aspects include legislation that allows for:

<u>Section 6:</u> Prescription of control measures relating to the utilisation and protection of vleis, marshes, water sponges and water courses. These measures are described in regulations promulgated in terms of the Act, as follows:

Regulation 7(1): Subject to the Water Act of 1956 (since amended to the Water Act 36 of 1998), no land user shall utilise the vegetation of a vlei, marsh or water sponge or within the flood area of a water course or within 10 m horizontally outside such flood area in a manner that causes or may cause the deterioration or damage to the natural agricultural resources.

Regulation 7(3) and (4): Unless written permission is obtained, no land user may drain or cultivate any vlei, marsh or water sponge or cultivate any land within the flood area or 10 m outside this area (unless already under cultivation).

4.4 Biodiversity Act

To provide for the management and conservation of South Africa's biodiversity within the framework of the National Environmental Management Act of **1998;** the protection of species and ecosystems that warrant national protection; the sustainable use of indigenous biological resources; the fair and equitable sharing of benefits arising from bio-prospecting involving indigenous biological resources; the establishment and functions of a South African National Biodiversity Institute.

4.5 Cape Nature Conservation Ordinance (Ordinance 19 of 1974; amended in 2000)

This ordinance provides measures to protect the natural flora and fauna, as well as listing nature reserves in the Western Cape that are managed by the Western Cape Nature Conservation Board (WCNCB). This ordinance, with the Western Cape Nature Conservation Board Act of 1998 was amended in 2000 to become the Nature Conservation Laws Amendment Act. Lists of endangered flora and fauna can be found in this act.

4.6 National Water Act (1998)

The main regulatory requirements with regards to aquatic features relates to the National Water Act No. 36 of 1998 (NWA). Use of water is governed by Schedule 1 of the Water Act (this covers reasonable domestic use and storage, gardening, watering of animals, and recreational use) and by Section 21, which regulated a further 11 consumptive and non-consumptive water uses that require authorisation. These include:

a. Taking water from a water resource;
b. Storing water;
c. Impeding or diverting the flow of water in a watercourse;
d. Engaging in a stream flow reduction activity;
e. Engaging in a controlled activity identified and declared as such in terms of the Act;
f. Discharging waste or water containing waste into a water resource through a pipe, canal, sewer, sea outfall or other conduit;
g. Disposing of waste in a manner which may detrimentally impact on a water resource;
h. Disposing in any manner of water which contains waste from, or which has been heated in, any industrial or power generation process;
i. Altering the bed, banks, course or characteristics of a watercourse;
j. Removing, discharging or disposing of water found underground if it is necessary for the efficient continuation of an activity or for the safety of people; and
k. Using water for recreational purposes.

These water uses may impact on the integrity and function of water resources and the overall quality of the resource and therefore must be authorised as a water use by the Department of Water and Sanitation (DWS) or competent authority (such as a Catchment Management Agency). The process to be followed to obtain authorisation for these categories of water use is different for each water use, and relates to the **risk** associated with the water use. Lower risk water uses fall under a number of GAs, and authorisation is a simpler, faster process than for licensing.

GN 1199 (18th December 2009, amended 26th August 2016) provides guidance and the conditions of authorisation regarding impeding and diverting the flow in a watercourse (Section 21 (c)), or altering the bed, banks, course and characteristics of a watercourse (Section 21 (i)), and is thus applicable to encroachment of a built footprint into an aquatic feature or its recommended ecological buffer, and the construction or widening of river or wetland crossings.

The Boschendal Village development encroaches slightly into the regulatory zone, both in terms of the 1:100 year floodline, and in that the development is within 500 m of a wetland (see Figure 5.12). In addition, the new water supply pipeline and sewer pipeline will impact on watercourses, as the pipes must cross over these systems. Accordingly, a full WULA would be necessary, unless it is established with DWS that the activities are low risk and subject to registration only. The draft risk assessment matrix disseminated by the DWS in 2015 was filled in for the Boschendal development in June 2015 (see Appendix 1), and the conclusion was that all risks associated with the development could be reduced to **low to negligible**, with full implementation of the proposed mitigation measures.

However, sewer pipelines are excluded from GA 1199, and thus a full WULA will be necessary for this particular activity.

4.7 Western Cape Provincial Spatial Development Framework (Draft, 2013)

Policies regarding the protection of biodiversity and ecosystem services in the Western Cape are:

- The Western Cape's Critical Biodiversity Area (CBA) mapping, which CapeNature are currently updating and refining, together with the draft priority climate change adaption corridors, comprise the spatial extent of the Western Cape's biodiversity network. This must inform spatial planning and land use management decisions throughout the province.
- Using the latest available CBA mapping as a primary informant, regional, district and municipal SDFs must delineate Spatial Planning Categories (SPCs) that reflect suitable land use activities in the different CBA categories.
- To complement CapeNature's protected area expansion strategy and their Stewardship programme, SDFs should highlight priority areas outside the protected area network that are critical for the achievement of the province's conservation targets.

Policies regarding the management, repair and optimisation of inland water resources are:

- Given current water deficits, which will be accentuated by climate change, a 'water wise' planning and design approach in the W Cape's built environment is to be mainstreamed.
- Rehabilitation of degraded water systems is a complex inter-disciplinary intervention requiring built environment upgrading (i.e. infrastructure and the built fabric), improved farming practises, as well as the involvement of diverse stakeholders.
- Introduce and retrofit appropriate levels of water and sanitation systems technologies in informal settlements and formal neighbourhoods with backyard shacks as a priority.
- An overarching approach to water demand management is to be adopted – firstly efficiencies must be maximised, storage capacity sustainably optimised and ground water extraction sustainably optimised, with the last resort option of desalination being explored, if necessary.
- Protection and rehabilitation of river systems and high yielding groundwater recharge areas, particularly in areas of intensive land use (i.e. agricultural use, industry, mining and settlement interactions) should be prioritised.
- Regional Plans to be developed for Water Management Areas to ensure clear linkages and interdependencies between the natural resource base (including water resources) and the socio-economic development of the region are understood and addressed.
- Agricultural water demand management programmes to be developed with an emphasis on the Breede Valley and Oliphants / Doorn agricultural areas. Industrial water demand management programmes to be developed with an emphasis on Saldanha, Southern Cape and Cape Town. Settlement water demand management programmes to be developed with an emphasis on the Cape Town functional region.
- Government facilities (inclusive of education, health and public works facilities) to lead in implementing effective and efficient water demand management programmes.

- Continue with programmes (such as Working for Water) which reduce the presence of alien vegetation along river systems.

4.8 Stellenbosch Municipality Spatial Development Framework

The principles contained in the Stellenbosch SPF that are pertinent to this study include:

- All rivers above a minimum size shall be protected by river conservation zones of 10-30m on either side of the bank, depending on the width and maturity of the river (as determined by an aquatic ecologist or land surveyor). These zones should be returned to their natural riparian status for passive recreational use only, and no urban development or intensive agriculture shall be permitted within them.
- No foundations of permanent buildings shall be located within the 1:100 year flood lines (as determined by a hydrological engineer).
- Peak water demand should be accommodated with supplementary storage and recycling (e.g. rainwater tanks, grey water recycling) of water so that the municipality can focus on satisfying base demand and meeting the needs of the poor.
- Urban water demand management programs should be implemented to ensure that urban water demand does not undermine agricultural needs, including:
    - Rainwater harvesting should be mandatory on all new urban developments, and retrofitting of rainwater harvesting should be encouraged on all existing developments (where heritage constraints allow for this).
    - Grey water recycling should be promoted on all residential, commercial and industrial units with gardens.
- Water conservation measures should be adopted, for example minimising unaccounted for water through leak repair and pressure adjustment, installing water meters, educating consumers about water saving, promoting water saving devices and promoting water-wise gardening.
- Technologies that facilitate the efficient use of irrigation water should be encouraged.
- Conservation areas should continue to enjoy the highest possible level of protection in order to ensure water quality and quantity at least in the upper reaches of the river system.
- The eradication of alien vegetation from all areas should be supported.
- Sensitive biodiversity areas should be mapped, and clear and appropriate guidelines introduced to conserve them.
- Crest lines should be kept free of buildings and intensive agriculture to protect biodiversity.
- Ridge lines should be used for properly managed walking trails to increase recreational potential, tourism and income.
- Outside of formal conservation areas, land owners should be encouraged to conserve vegetation classified by SANBI as Endangered or Critically Endangered (particularly along ridge lines) and to link to existing conservancies (e.g. through the CapeNature Stewardship Program). These land uses should be classified in the Core SPC.

5 Description of proposed development

Boschendal Village will be a publicly accessible, walkable village, with a mix of land uses. A number of development proposals have been put forward over the last decade or so. These are described below.

5.1 Proposed alternatives

Apart from the no-go option, there are five development alternatives. These are described below, with most of the text taken from the Alternatives document provided by @Planning town planners in December 2015.

5.1.1 Alternative 1: No-go option

This option is basically maintenance of the status quo. The existing zoning is Agriculture, and land-use is predominantly vacant land and dwellings on Portion 7, and packing sheds, derelict labourers' cottages, a pallet factory, clinic, vacant land and a small area of pear orchard on Portion 10. The pallet factory, clinic and a school have been approved as consent uses, and the remaining area can be used for agriculture without requiring planning approval.

5.1.2 Alternative 2: Retirement village (2011)

The original proposal developed during the previous environmental authorisation process by Dennis Moss Partnership (2011) was a retirement village comprising:

- 138 erven for residential purposes;
- 25 assisted living apartments under sectional title;
- A frail care centre with 20 beds;
- A convalescence facility with 12 beds;
- A rehabilitation centre;
- A clubhouse including dining rooms and meeting rooms;
- A small commercial and information centre, and
- Open space and access ways.

From a freshwater ecological perspective, this option would cover the most ground, leading to a loss of both open space and wetland area. This alternative would also generate the highest volume of stormwater.

Figure 5.1 Site Development Plan: Alternative 2 (DMP 2011)

This alternative was rejected due to a number of issues, which dealt primarily with the heritage and town planning, and so is not assessed further.

5.1.3 Alternative 3: Rural Village, September 2014

The idea of a Rural Village was introduced in 2014 to address a number of heritage and social fabric issues relating to Alternative 2. This option comprises the following:

- ±23 000 m^2 Gross Leasable Area (GLA) mixed use development, including shops, restaurants, places of entertainment, a market, offices and other related businesses;
- Hotel or guest accommodation with ±110 rooms, and
- 715 Residential dwelling opportunities at various densities (from single dwelling to 3-storey apartments).

The development footprint of this proposal is **34.5 ha**. The following issues relating specifically to the wetlands and rivers on and around the site were raised:

- The densities in the village are too high, leading to loss of all open space;
- Insufficient capacity for electricity infrastructure to accommodate would have required significant external infrastructure to be installed, and services would need to cross over the Berg River, and
- This development layout did not adequately take wetlands on the site into consideration.

Alternative 3 was rejected due to the above issues, and also a number of town planning, social and economic issues. It is not assessed further.

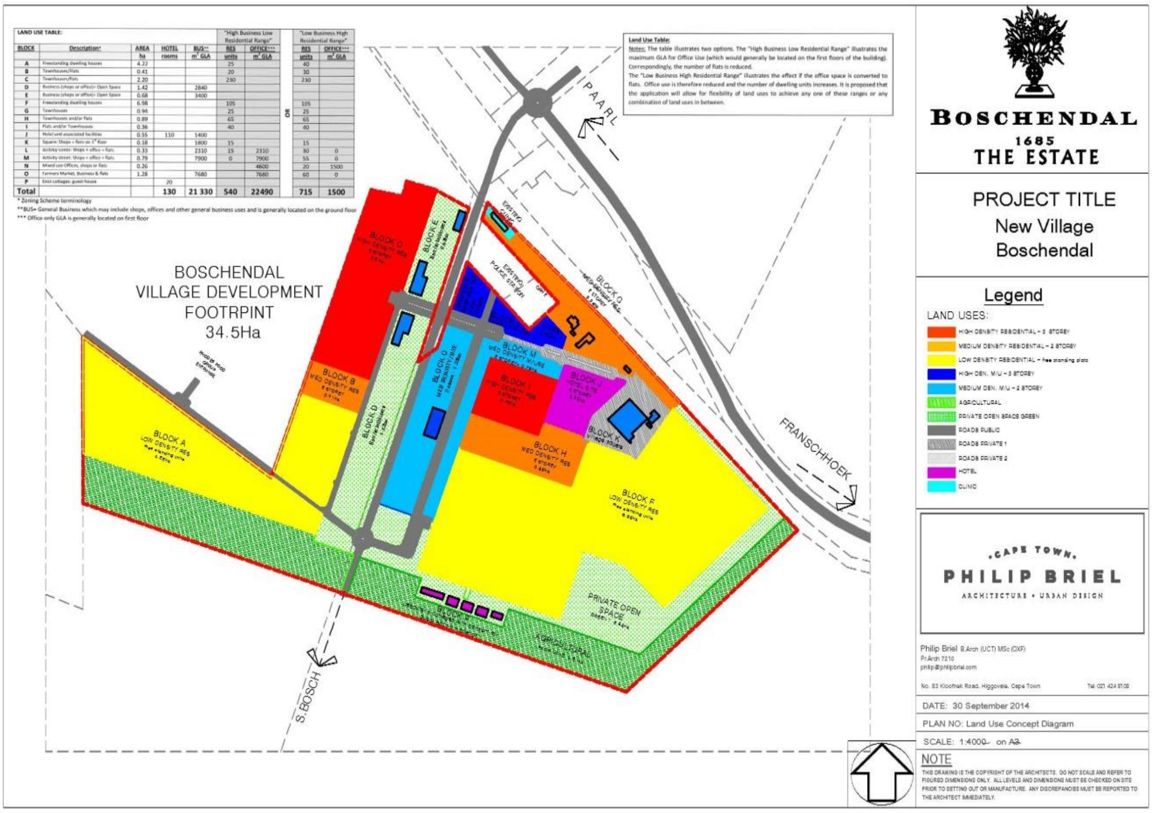

Figure 5.2 Alternative 3 (Philip Briel, 2014).

5.1.4 Alternative 4: Rural Village, May 2015

Alternative 4 is similar to Alternative 3 but with a reduction in the number of residential units and the GLA of the mixed use development area.

- The core of the development will comprise 14 500 m² GLA mixed-use development, including shops, restaurants, places of entertainment, offices and other related businesses;
- A hotel or guest accommodation with approximately 100 rooms, and
- Approximately 440 residential units.

The development footprint is **27.8 ha**. A small portion of the development footprint falls within the 1:100 year floodline of the Dwars River (refer to Figure 5.8), and this area will be filled in to provide a platform for a row of free-standing dwelling houses that will form the eastern edge of the village. The strip is approximately 30 m wide, and the fill would be between 0.5 and 1.5 m deep.

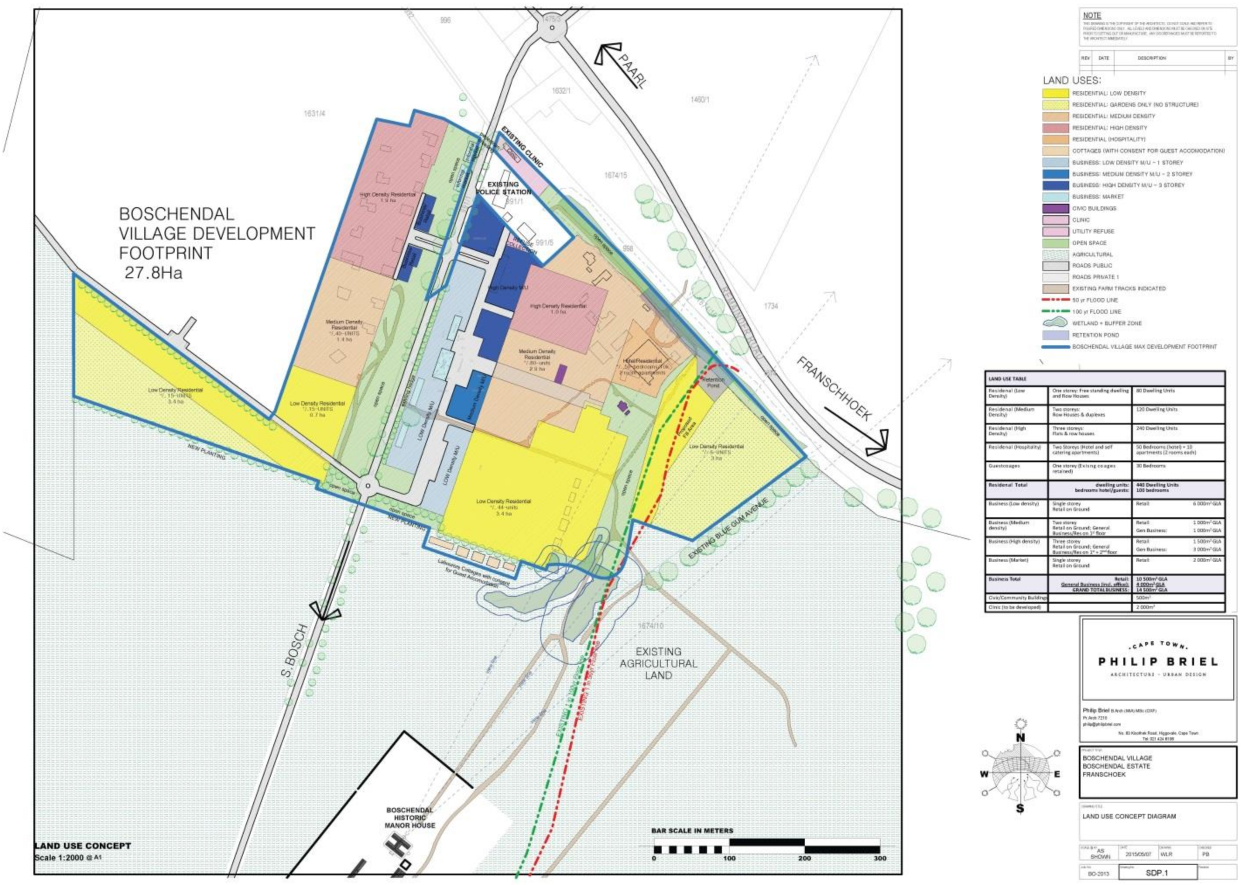

Figure 5.3 **Alternative 4 (Philip Briel, 2015).**

5.1.5 Alternative 5a: Rural Village, October 2015 –Preferred alternative

Alternative 5 is similar to Alternative 4, but the layout was refined taking into account a shift in design principles, notably the rotated axis for the grid layout, and the large open space which becomes an open space “werf” linking with the historical werf of the Boschendal Manor. The clinic was also relocated to a more appropriate location, and a maintenance and waste recycling area introduced.

This alternative comprises:

- A total of 425 dwelling units;
- Guest accommodation of approximately 100 bedrooms;
- 4500m^2 GLA for retail, and 9000m^2 GLA for General Business;
- Civic and Community buildings (500m^2);
- A clinic (2000m^2)
- Early childhood development and aftercare centre for 120 children
- Recycling and maintenance area (±200m^2 building; ±2000m^2 land area).

Figure 5.4 Alternative 5a –Preferred option. (source: Philip Briel Architects).

The development footprint for this alternative is **27.45 Ha.** As for Alternative 4, a small portion of the development footprint falls within the 1:100 year floodline of the Dwars River, and would need to be filled in. A servitude will prohibit buildings within the post-development 1:100 floodline. The stormwater engineers confirmed that filling in a small portion of the Dwars River floodplain below the 1:100 floodline will have negligible consequences in terms of the accommodation of flood volumes.

Furthermore, a significant portion of land is set aside as open space in this Alternative, in order to protect the wetlands on the site.

5.1.6 Alternative 5b: Rural Village, October 2015

The only difference between Alternatives 5a and 5b is that the houses proposed below the 1:100 year floodline have been removed from the layout. The development footprint for this alternative is **24.85 ha.**

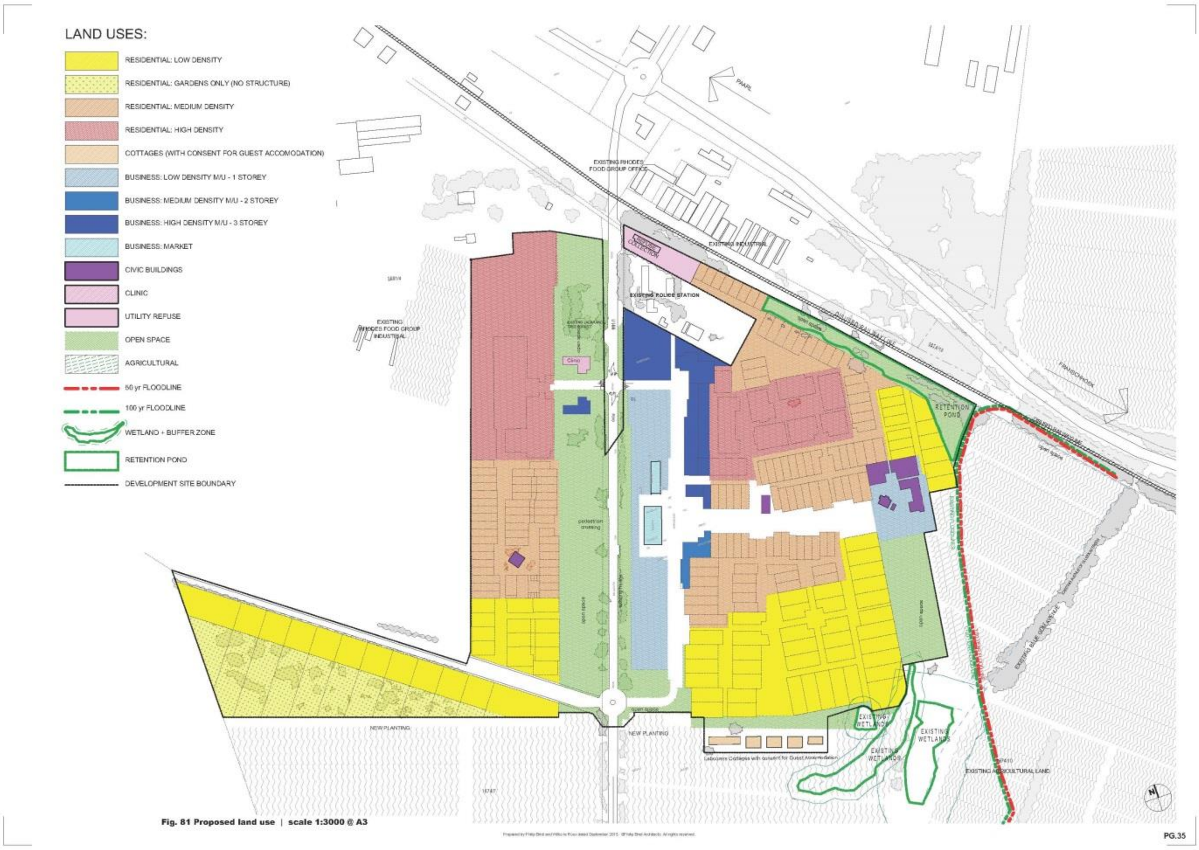

Figure 5.5 Alternative 5b.

5.1.7 Alternative 5c: Rural Village, Preferred option, May 2016

An additional alternative was added to the assessment process in May 2016. The only difference between Alternatives 5a and 5c is that the residential erven along the eastern boundary of the village are reduced in size so that their gardens do not extend below the revised 1:100 year floodline (after infilling in order to build). Furthermore, the pear orchard (±2.5 ha) on the eastern edge is retained. The development footprint for this alternative is **25.2 ha.** Infilling of a small portion of the floodplain below the 1:100 year floodline is still required.

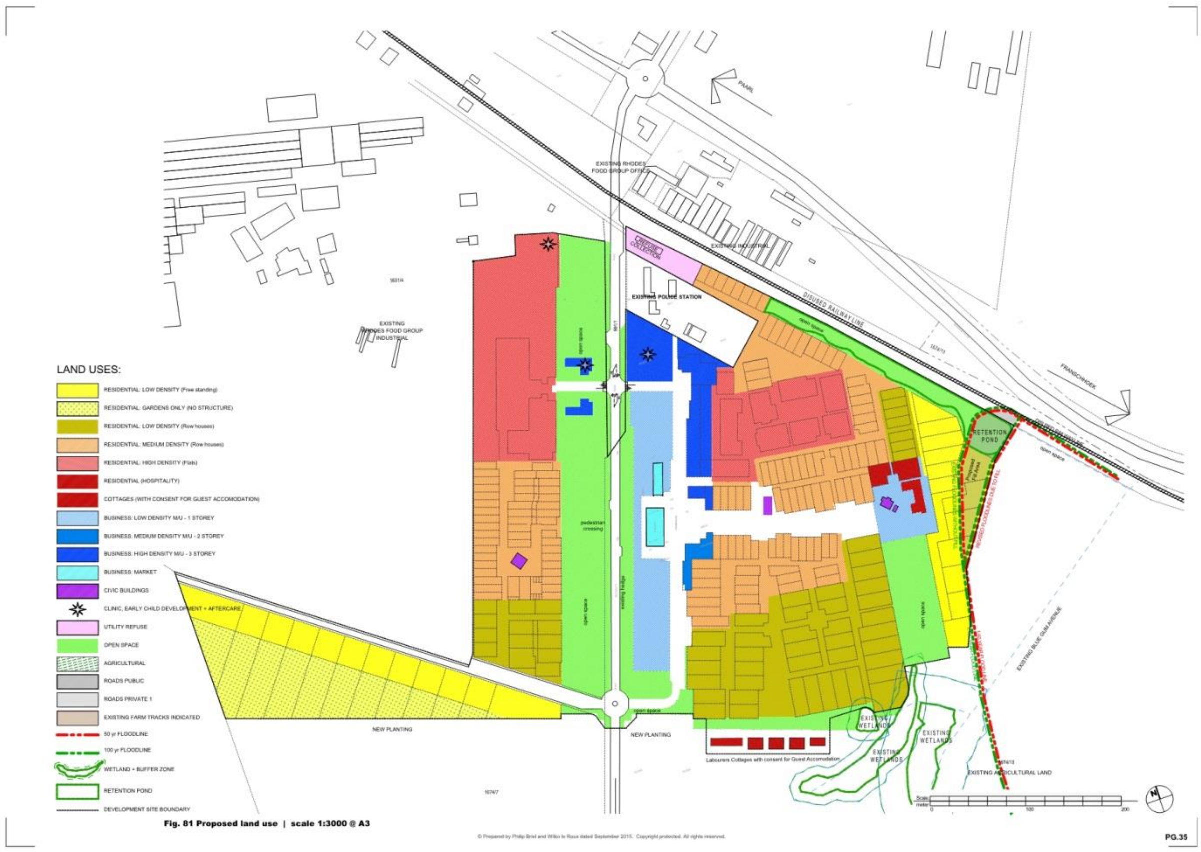

Figure 5.6 Alternative 5c.

This alternative comprises:

- A total of 475 dwelling units;
- Guest accommodation of approximately 100 bedrooms;
- 5500m^2 GLA for retail, and 9000m^2 GLA for General Business;
- Civic and Community buildings (500m^2);
- A clinic (2000m^2)
- Early childhood development and aftercare centre for 120 children
- Home Owners' Utility area (±500m^2).

5.2 Services

5.2.1 Roads

Access to the development will be off the R310 and in order to achieve this, two new traffic circles will need to be built. One will be at the R45/R310 intersection and the other at the existing intersection of the R310 and Minor Road 5230. A new intersection off the R310 is also proposed, providing an additional access point to the village.

5.2.2 Stormwater and sewage

A stormwater drainage system will be constructed to accommodate the external flows presently crossing the site, and runoff produced by the development. In this way, post-development stormwater runoff will not exceed pre-development volumes. The wetlands on the site, including the long wetland associated with the railway line along the northern boundary, will be incorporated into the stormwater management system, thereby maximising the attenuation of water on site, allowing water to filter into the ground while improving water quality. A new detention pond will be constructed at the downstream end of the railway wetland, with the Dwars River being the final receiving ecosystem (see Figure 5.8). There is a necessity to construct a new stormwater channel (unlined) and pipe (900 mm diameter). Gabion drop structures will be constructed at the outlet of the stormwater pond, and at the outlet of the pipe into the river, to take up the level difference and reduce the likelihood of erosion.

Sewer pipes and a pump station will be installed, collecting sewage from the site by gravity main and pumping it via rising main to the Pniel Waste Water Treatment Works. The rising main will run through the road reserve alongside the Helshoogte Road, to the WWTW, and will cross over off-site Streams 1 and 2. The new pump station would be located close to the Dwars River bridge, on the left-hand bank of the river. It would occupy a space of approximately 20 m x 10 m, with a sump below ground and an above-ground structure of about 5 m x 5 m. The ground level here is below the 1:50 year floodline, so the floor level of the pump station will have to be elevated above the 1:100 year floodline (this is approximately 1 m above the existing ground level at this point). The structure will be lined with water-retaining reinforced concrete, and is thus sealed to prevent leakage into the Dwars River, and water flowing into the structure. The site is out of the main active channel of the Dwars River, so it is unlikely that it will affect flow in the river. The sewage system for the development has been designed to be able to accommodate future inputs from other developments.

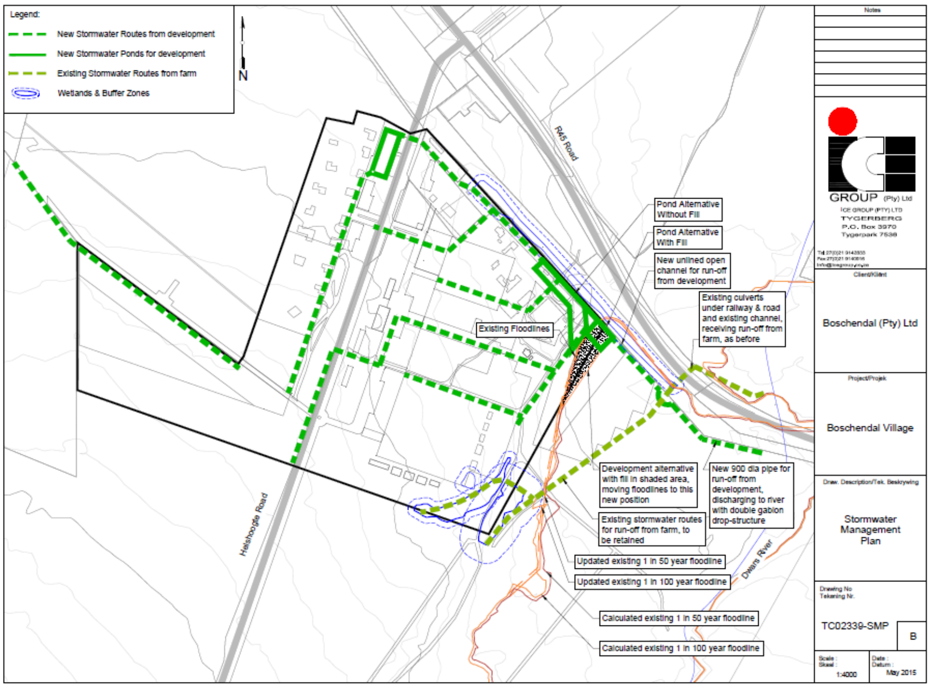

Figure 5.7 **Stormwater infrastructure on the site, showing all proposed channels.**

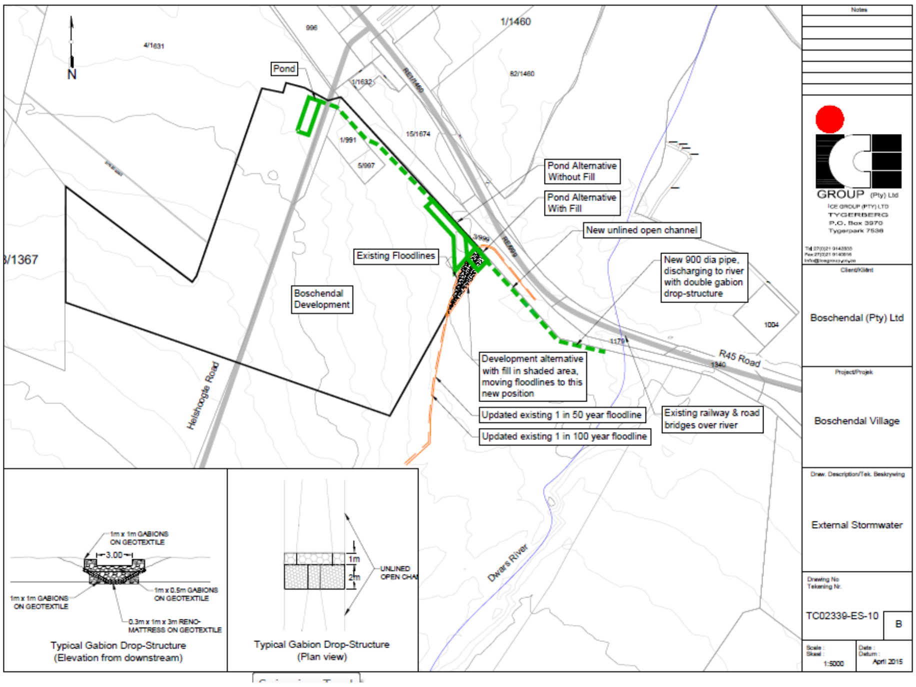

Figure 5.8 Stormwater infrastructure, showing the proposed stormwater pond, and detail regarding the outlet. This diagram also shows the extent of fill area required for Alternatives 4 and 5a.

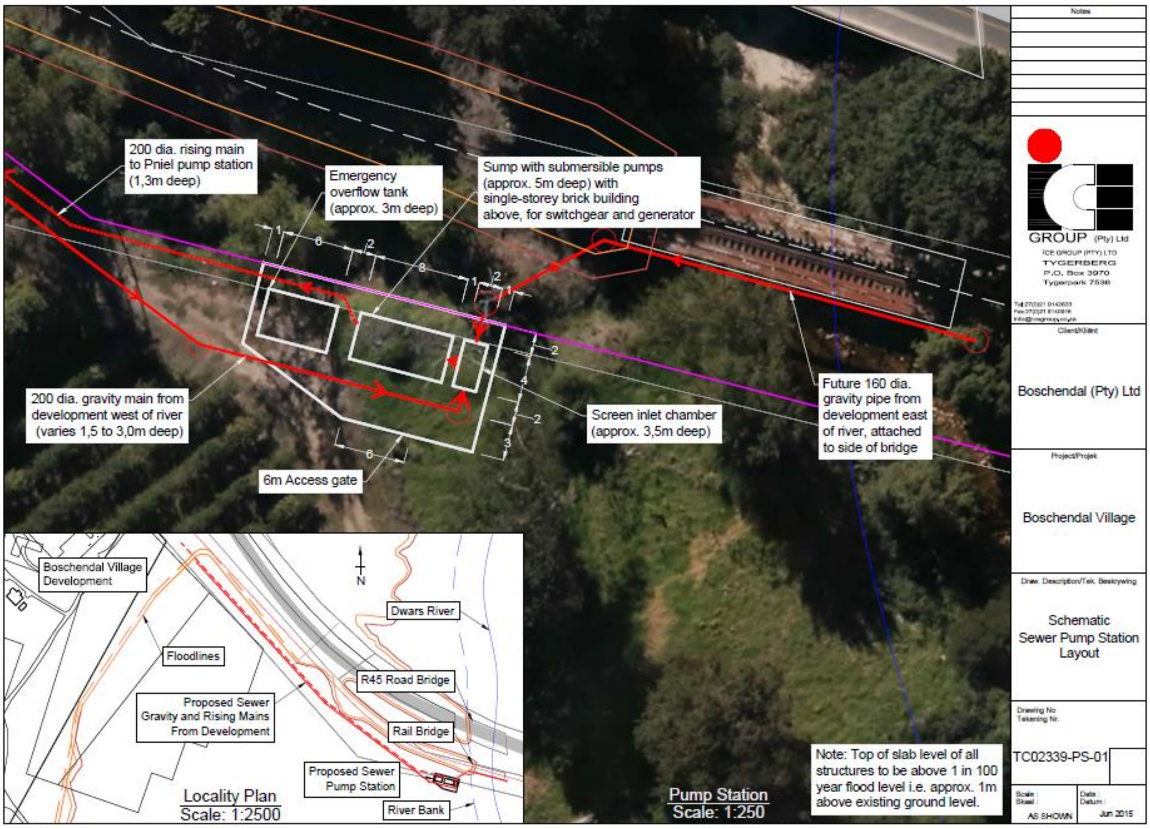

Figure 5.9 Schematic of proposed sewage pump station next to the Dwars River bridge.

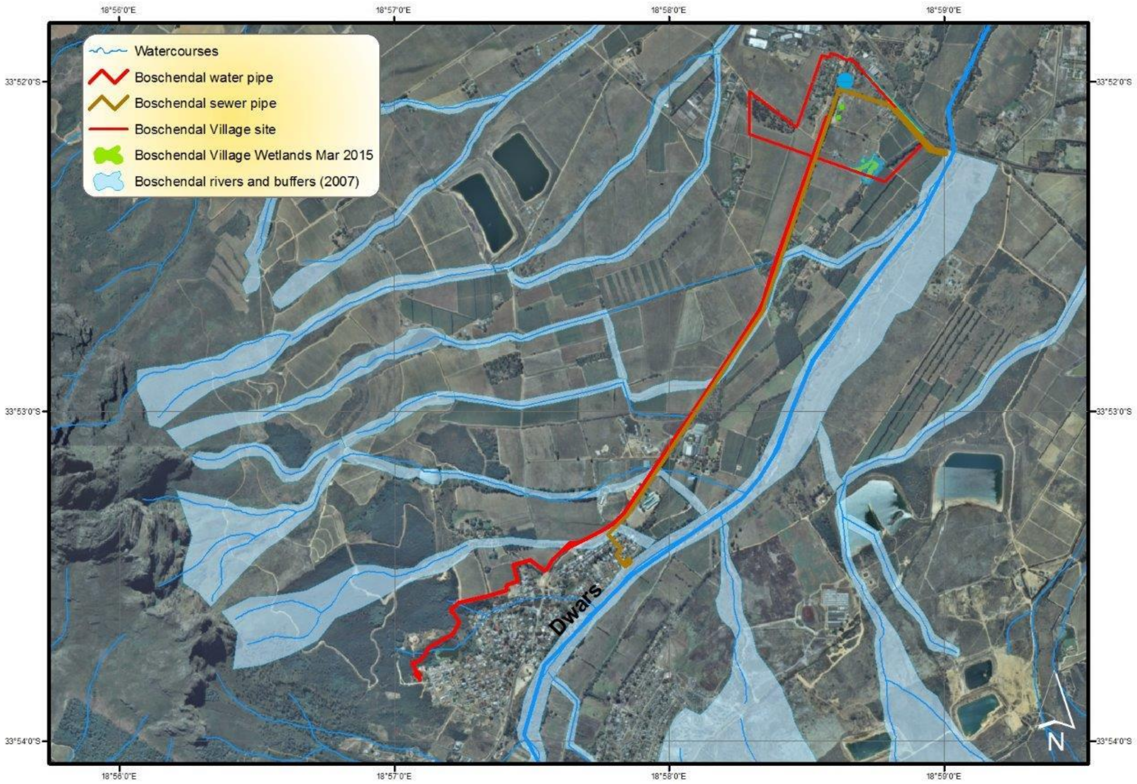

Figure 5.10 Overview of the pipeline routes for both the water supply and sewer pipelines.

5.2.3 Water and Electricity

For all layout options, an external gravity water mains pipe will need to be laid within the road reserve along the Helshoogte Road (R310) in order to convey water from the existing bulk supply pipeline in Pniel, down to the Boschendal site. The water mains will cross over off-site Streams 1 – 5 and a number of agricultural and stormwater ditches ditches in at least six places –. Watercourses/channels will be crossed either using pipes on the surface, threading these through existing culverts, or by thrust-boring, i.e. jacking or pushing the pipe under the watercourse or channel without excavating through the watercourse or channel (see Figure 5.11). Water supply pipes will also be laid onto and across the site, with an on-site reservoir for water storage and supply (see Figure 5.12 for location of reservoir).

Sufficient electricity is locally available for the proposed development, however, a new reticulation network, including new mini-substations will be constructed on site.

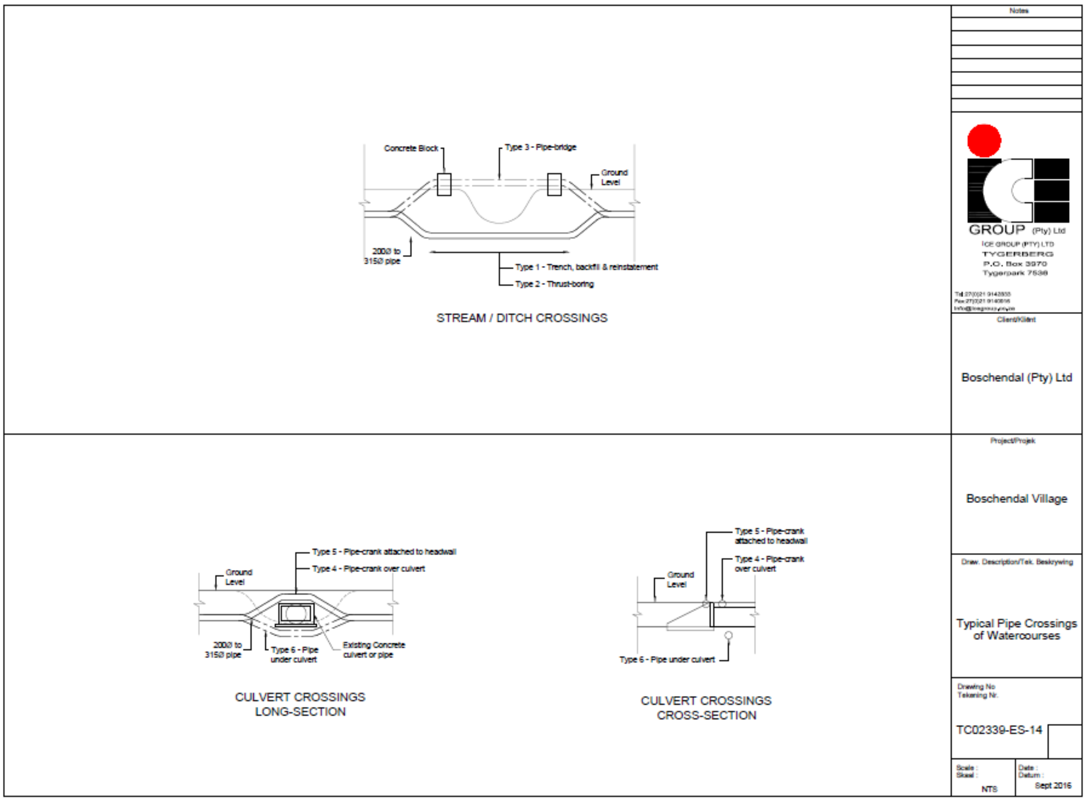

Figure 5.11 **Typical pipe crossing over watercourses and ditches.**

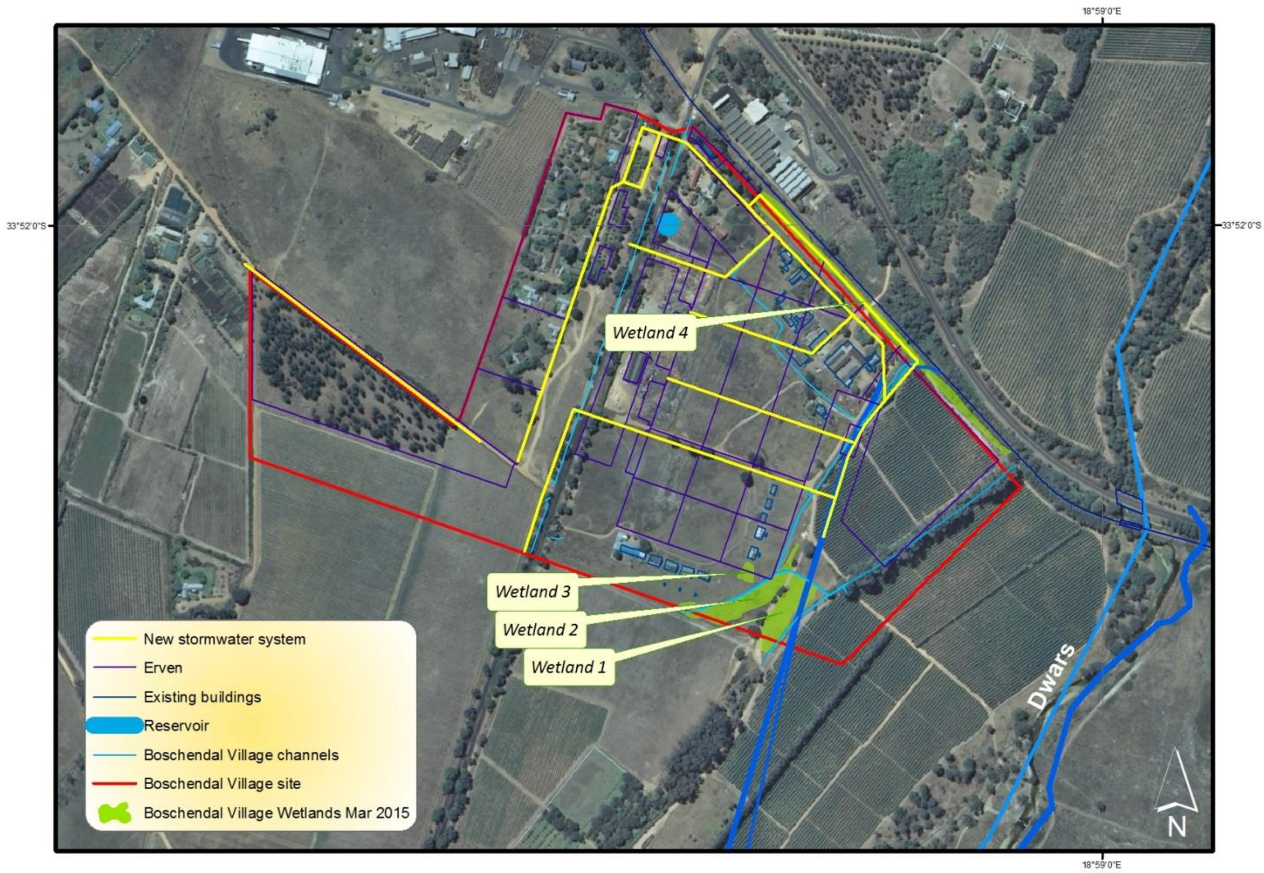

Figure 5.12 **Aerial photograph with the site boundary (red line) and some of the services (see legend).**

6 Description of probable impacts and mitigation measures

The following sections describe the impacts that are expected to affect the biodiversity and/or ecosystem functioning of the freshwater ecosystems observed on and around the Boschendal Village site, for Alternatives 1, 4, 5a and 5b.

6.1.1 Layout

The following impacts and mitigation measures relate to Alternatives 4, 5a, 5b and 5c, as there are no layout impacts associated with the status quo, Alternative 1.

Impact	Mitigation measures
Loss of open space – no matter the layout, development of the site will lead to the loss of open space around and between the natural ecosystems on the site. This connectivity is important, despite the poor condition of some of the wetlands. The intensity of this impact is low to moderate for all alternatives due to the fact that the site has already been highly transformed from natural over many years. This impact will be marginally less intense for Alternative 5b, as the built footprint for this option occupies the least space, and there is no development below the 1:100 year floodline. This will effectively create an ecological corridor contiguous with the Dwars River floodplain, extending along the eastern boundary of the property, and up to and including the northern boundary.	o All sensitive ecosystems should be allowed a development setback or buffer, in order to provide some protection from the impacts of the development. It is recommended that a 10 m buffer be allowed around wetlands 2 , 3 and 4, and a 30 m buffer around wetland 1. o Allow for an ecological corridor to connect all of the wetlands, preferably with a connection to the Dwars River and its floodplain (i.e. contiguous with the 1:100 year floodline, below which no development should occur).
Loss of floodplain area – Alternatives 4, 5a and 5c would require a small area of Dwars River floodplain to be filled in in order to provide a platform for a row of houses. All alternatives will also require a small platform to be filled in for the construction of the sewage pump station. Although the engineers have asserted that these activities will not impact on the floodplain's capacity to accommodate floodwaters nor will they alter the flow in the river, this does represent a small loss of natural floodplain, which is considered part of the natural watercourse.	o Where filling in of the floodplain is unavoidable (Alternatives 4, 5a and 5c), hardened surfaces (buildings, roads) must be kept out of the "revised" 1:100 year floodline. o The filled area must be kept as natural as possible, with indigenous planting and minimisation of additional hardened surfaces (e.g. roads, parking areas).
Hardening of the banks of the Dwars River, in order to stabilise the stormwater outlet structure and to construct gabion drop structures to take up the level difference between the stormwater pipe outlet and the river. This will be required for all alternatives.	o The gabions must be placed in such a way as to avoid erosion on the river banks and floodplain. o The size of the structure should be minimised, in order to minimise the hardening of the river bank and loss of natural vegetation. o The drop structure must be placed outside of the active channel.
Pipe crossings across watercourses or water channels	o Crossings over natural stream channels (watercourses) must be minimised, if possible.

6.1.2 Construction phase

The following impacts and mitigation measures apply to Alternatives 4, 5a, 5b and 5c.

Impact	Mitigation measures
Dumping of building materials (sand, soil, bricks etc) in sensitive areas – such dumping would damage the soil structure, and would destroy or shade out plants growing in and around these ecosystems. Dump areas frequently lead to the compaction of soils, which can influence re-growth of plants. Invasive alien plants frequently take advantage of disturbed areas such as these.	o Ensure that all building materials are stored at least 50m away from the edges of the wetlands, as demarcated prior to construction. Storage areas should be bunded adequately to prevent contaminated runoff from entering the wetlands or the Dwars River. o Materials should be stored in piles that do not exceed 1.5m in height and should be protected from the wind, to prevent spread of fine materials across the site. o Sensitive areas that are impacted by the dumping of materials must be ripped and re-planted after construction is complete.
Pollution of the wetlands or Dwars River through leakage of fuels, oils, etc. from construction machinery. Due to the fact that the wetlands are seasonal, with little or no inundation in summer and flushing only in winter, it is likely that pollutants will accumulate and persist for some time.	o Construction close to sensitive areas should take place during the dry season, to reduce the risks of contamination of the ecosystems through rainfall and runoff. o Machinery prone to oil or fuel leakage must be located at least 50m away from any freshwater ecosystem, and the area adequately bunded in order to contain leakages. o Water pumps and cement mixers shall have drip trays to contain oil and fuel leaks – these must be cleaned regularly. o Suitable toilet and wash facilities must be provided to avoid the use of sensitive areas for these activities. These service areas must be maintained, and toilets emptied on at least a weekly basis.
Destruction or deterioration of freshwater habitat as a result of foot and vehicular traffic – access across and around the wetlands and drainage channels onto and across the building site, and for road construction and pipe laying, is likely to lead to damage of soils and vegetation. Regular use of a particular area will lead to the compaction of soils.	o Pathways and access roads must be routed around the wetlands and should cross drainage channels as seldom as possible. o Sensitive areas must clearly be demarcated and fenced off (using temporary fencing and danger tape) before any construction work or site preparation begins. These are no-go areas during the construction process. o Affected areas must be ripped and re-planted after construction, to the satisfaction of the ECO.
Excavation and / or infilling of the wetlands, watercourses or the floodplain of the Dwars River – this will be required in order to prepare the site for the construction of stormwater detention ponds (such as that envisaged in Wetland 4), and for pipe crossings that do not follow existing disturbed	o Excavation and infilling must be restricted to areas where this is necessary. o Any such work must be done during the dry season, to minimise impacts on the freshwater fauna and flora. o Pipe crossings over the Dwars River or any

Impact	Mitigation measures
footprints (e.g. roads/bridges).	watercourses, if entirely necessary, should follow existing roads or be attached to existing bridges. If a new crossing must be constructed, this should be done using thrust-boring (directional drilling) under the river or stream and outside the riparian zone, rather than trenching, in order to minimise disturbance to flow, and the bed and banks of any freshwater ecosystem. o The sensitive areas (i.e. the edges of the buffers around the wetlands, river banks) not affected by construction must clearly be demarcated and fenced off (using temporary fencing and danger tape) before any construction work or site preparation begins. These are no-go areas during the construction process, except where work is occurring. o Affected areas must be rehabilitated after construction, to the satisfaction of the ECO, and according to a construction EMP.
<u>Disturbance of freshwater fauna and flora</u> – the presence of construction teams and their machinery will lead to noise and light pollution in the area, which will disturb aquatic and terrestrial fauna and flora.	o The construction site and pathways must avoid sensitive areas. If lights are used, these must be directed away from all sensitive areas. o The sensitive areas (i.e. the edges of the buffers around the wetlands, river banks) not affected by construction must clearly be demarcated and fenced off (using temporary fencing and danger tape) before any construction work or site preparation begins. These are no-go areas during the construction process, except where work is occurring.
<u>Increased input of sediments</u> – construction activities in the wetlands, smaller watercourses along the pipeline routes or Dwars River floodplain or channel may lead to increased input of mobile sediments, especially during the wet winter months.	o Construction in and around the wetlands and Dwars River (e.g. sewage pump station) should take place during the dry season, to reduce the risks of contamination through rainfall, runoff and erosion. o Pipe crossings over the Dwars River or any watercourses, if entirely necessary, should follow existing roads or be attached to existing bridges. If a new crossing must be constructed, this should be done using thrust-boring (horizontal directional drilling) under the watercourse, rather than trenching. o Special care should be taken around storm and heavy rain events. The construction site should be inspected for erosion damage at these times. o If construction areas are to be pumped of water (e.g. after rains), this water must first be pumped into a settlement area, and not directly into a natural ecosystem.
<u>Introduction and spread of invasive alien plants</u> –	o All soils and top material must be bought

Impact	Mitigation measures
top material brought onto the site, for filling and landscaping can lead to the introduction of alien or invasive seedbanks.	from reliable sources, and must be free of alien seeds or grass runners. o Constant monitoring of the construction site by the Site Engineer and ECO must occur, and all alien plant species removed from or destroyed on the site.

6.1.3 Operational Phase

A detailed operational EMP should be prepared, incorporating the mitigation measures below. The EMP must provide sufficient detail on the management of the natural areas, and land that connects them (corridors), so that these are protected from deterioration and maintained in a satisfactory state (e.g. ongoing removal of alien invasive vegetation).

The following impacts are appropriate for all options, however, there are few mitigation measures that are appropriate for the no-go option, as there would be no commitment made to implementing these, apart from those that are required by law, such as control of alien plants.

Impact	Mitigation measures
<u>Increased water demand and water supply infrastructure</u> Water for the development will come from the Wemmershoek bulkwater pipeline, which carries water from the Berg River catchment to City of Cape Town. The Berg River catchment is considered a water stressed catchment.	o Landscaped areas and gardens must be planted with species that do not require much watering. o Water demand management must be implemented within the development, a specified in the Provincial and Stellenbosch Municipality SDFs (see Section 4). o Rainwater storage tanks should be built on every erf. o Care must be taken in the location of water supply infrastructure, in order to avoid sensitive areas. o Where pipes must cross the river channel or wetlands on the property, this should be done using areas that will be disturbed, such as roads or tracks.
<u>Decrease in water quality</u> A decrease in water quality can follow from discharge of stormwater into the Dwars River. Residential stormwater is generally not heavily polluted, but does contain oil and petrol and, of greater significance, nutrients such as nitrates and phosphates. These nutrients can lead to the proliferation of algae in areas of standing water, which can be problematic and unsightly. Pollution from leaks from the sewer pipe or from manholes, especially close to the watercourses and ditched located along the pipeline route will lead to severe pollution of the watercourse or ditch, and ultimately of the Dwars River.	o Stormwater should be allowed to flow along unlined channels before discharge into either natural or created wetland areas. This will allow some infiltration of water into the ground, so reducing the quantity of runoff and improving the quality. o Wetland 4 can be used for stormwater detention. o Sand filters should be constructed, which effectively trap oil and grease. o Hardened areas should be associated (where possible) with vegetated filter strips (broad, sloped vegetated areas that accept shallow runoff from hardened surfaces), bioswales (landscaped

Impact	Mitigation measures
This impact is likely to impact both the site area and any downstream areas should this polluted water leave the property. The decrease in water quality related to the discharge of treated effluent into the Dwars River was assessed in a previous EIA, so this is not taken into account here.	areas that are designed to remove silt and a number of pollutants from runoff, through ensuring that water flows slowly along these gently sloping (<6% slope) features, often planted with grass or other plant species, mulch or riprap), and / or bio-retention systems (vegetated areas where runoff is filtered through a filter media layer, e.g. sand, as it percolates downwards), all of which are designed to reduce the quantity of runoff leaving a hardened surface and entering the stormwater system. o The sewer pipe must be regularly (at least once a month) checked for leaks. o Leaks in the sewer pipe, or at manholes, must be fixed immediately.
<u>Increase in water quantity</u> The hardened surfaces of the development will lead to an increase in stormwater runoff generated by the site, thus increasing pre-development volumes. Discharge of stormwater into seasonal wetlands will lead to a loss of habitat quality, as these systems will be inundated for longer and will lose their seasonal character.	o Effort should be made to minimise the hardening of surfaces. Natural areas, gardens and road verges are areas where water can filter into the ground. The predominantly sandy soils of the site will allow this to occur. o Stormwater should not be conveyed directly into either wetland 1 or 2, but rather into detention/retention ponds and/or wetland 4, permeable areas, bioswales and/or constructed wetlands. o Wherever possible, parking areas should be constructed of permeable materials to allow for infiltration of water. o As a principle, hardened areas should be associated (where possible) with vegetated filter strips (broad, sloped vegetated areas that accept shallow runoff from hardened surfaces), bioswales (landscaped areas that are designed to remove silt and a number of pollutants from runoff, through ensuring that water flows slowly along these gently sloping (<6% slope) features, often planted with grass or other plant species, mulch or riprap), and / or bio-retention systems (vegetated areas where runoff is filtered through a filter media layer, e.g. sand, as it percolates downwards), all of which are designed to reduce the quantity of runoff leaving a hardened surface and entering the stormwater system.
<u>Disturbance of fauna and flora</u> Disturbance is likely as a result of the proximity of houses to the wetlands, including noise, light, trampling, domestic pets, etc.	o All sensitive ecosystems should be allowed a development setback or buffer, in order to provide some protection from the impacts of the development. It is recommended that a 10 m buffer be allowed around wetlands 2 , 3 and 4, and a 30 m buffer around wetland 1. o Lighting should face away from the wetland

Impact	Mitigation measures
	areas. o Domestic pets should be discouraged from entering the wetlands and their buffers, through the wise use of fencing and gates.
<u>Spread and establishment of invasive alien plants</u> Seeds and seedlings can be transported onto site for landscaping. Alien vegetation is also well adapted to establishing on previously disturbed soils and road verges.	o All newly planted areas must be planted with indigenous plants. Alternative grasses for lawns include *Stenotaphrum secundatum*, *Paspalum vaginatum* and *Cynodon dactylon*.. o Alien and invasive plants (including kikuyu) must be kept out of wetlands and rivers. o The spread of alien plant species into all natural areas must be prevented and monitored. o Road verges must be monitored for alien species.

6.1.4 Cumulative impacts

The proposed Boschendal Village development is located within the Groot Drakenstein Development Node, and is part of a more extensive development plan for this area, located at the intersection of the R310 and the R45. The impacts associated with this development need to be assessed in the context of future development of the Node (such as of the Meerlust Agri-Village).

The cumulative impacts of most concern in this area is the loss of open space, loss of wetland and river floodplain habitat, an increased number of crossings (mainly of services) over rivers and wetlands, increased water demand and use, and the discharge of treated effluent and stormwater into the Dwars River.

The upgrade of the Pniel WWTW was the subject of an earlier EIA, so is not taken into account here.

7 Environmental Impact Assessment

7.1 Protocol for the assessment of impacts

The evaluation of impacts was done using the criteria stipulated in the EIA Regulations of 2014, and listed in Table 7.1.

Table 7.1 Criteria used for the assessment of impacts associated with the proposed Boschendal development.

	Criterion	Description
a)	**Nature of Impact**	Define or describe the type of effect that a proposed activity would have on the environment. This description includes what is to be affected and how.
b)	**Extent**	Describe whether the impact occurs on a scale limited to the site area, local area (i.e. limited to within 10 km of the activity), or wider scale (i.e. regionally or nationally).
c)	**Duration**	Predict whether the lifespan of the impact will be short term (0 to 5 years); medium term (5 to 15 years); long term (i.e. beyond the operational phase but not permanently), or permanent (i.e. mitigation through natural processes or human intervention will not occur in such a way or in such time span that the impact can be considered transient).
d)	**Intensity**	Describe whether the intensity (magnitude/size) of the impact is high (environmental functions and processes are altered in such a way that they temporarily or permanently cease); medium (environmental functions continue but in a modified manner); low/negligible (no functions and processes are affected). The specialist study must attempt to quantify the magnitude of impacts, with the rationale explained.
e)	**Probability**	Describe the probability of the impact actually occurring as definite (impact will occur regardless of mitigations), highly probable (most likely), probable (distinct possibility), or improbable (low likelihood).
f)	**Reversibility**	The degree to which an impact can be reversed, from fully reversible, to partly reversible to irreversible.
g)	**Irreplaceable loss of resources**	The degree to which resources will be irreplaceably lost as a result of the activity – from fully replaceable, to partly replaceable to irreplaceable.
h)	**Cumulative effect**	The past, current and reasonably foreseeable future impact of an activity, considered together with the impact of activities associated with that activity, that in itself may not be significant, but may become significant when added to the existing and reasonably foreseeable impacts eventuating from similar or diverse activities
i)	**Significance**	The significance of impacts shall be assessed with and without mitigations. The significance of identified impacts on components of the affected environment shall be described as: - high where the impact could have a no-go implication for the development or a component of the development, regardless of any possible mitigation. - medium where the impact could have an influence on the environment which will require modification of the development design or alternative mitigation/s. - low where the impact will have a slight influence on the environment, but this can be accommodated without modification to the development design. - negligible where the impact will not have an influence on the environment.
j)	**Degree to which an impact can be mitigated**	The impact can be fully mitigated, partly mitigated or not mitigated.

7.2 Impact tables

7.2.1 Layout

Potential impacts on the freshwater ecosystems:	**Alternative 1 (No-Go)**	**Alternative 4**	**Alternative 5a**	**Alternative 5b**	**Alternative 5c**
Nature of impact:	**Loss of open space**				
Extent of impact:	n/a	Local area	Local area	Local area	Local area
Duration of impact		Permanent	Permanent	Permanent	Permanent
Intensity of impact		Low to moderate	Low to moderate	Low	Low to moderate

Potential impacts on the freshwater ecosystems:	Alternative 1 (No-Go)	Alternative 4	Alternative 5a	Alternative 5b	Alternative 5c
Probability of occurrence:		Definite	Definite	Definite	Definite
Degree to which the impact can be reversed		Partly reversible	Partly reversible	Partly reversible	Partly reversible
Degree to which the impact may cause irreplaceable loss of resources		Partly irreplaceable	Partly irreplaceable	Partly irreplaceable	Partly irreplaceable
Cumulative effect prior to mitigation		Low to moderate negative	Low to moderate negative	Low to moderate negative	Low to moderate negative
Significance rating of impact prior to mitigation		Low to moderate negative	Low to moderate negative	Low negative	Low to moderate negative
Degree to which the impact can be mitigated		Partly mitigated	Partly mitigated	Partly mitigated	Partly mitigated
Cumulative effect post mitigation		Low to moderate negative	Low to moderate negative	Low negative	Low to moderate negative
Significance rating of impact after mitigation		Low negative	Low negative	Negligible	Low negative

Potential impacts on the freshwater ecosystems:	Alternative 1 (No-Go)	Alternative 4	Alternative 5a	Alternative 5b	Alternative 5c
Nature of impact:	**Loss of floodplain area**				
Extent of impact:	n/a	Local area	Local area	Local area	Local area
Duration of impact		Permanent	Permanent	Permanent	Permanent
Intensity of impact		Low to moderate	Low to moderate	Low	Low to moderate
Probability of occurrence		Definite	Definite	Definite	Definite
Degree to which the impact can be reversed		Fully reversible	Fully reversible	Fully reversible	Fully reversible
Degree to which the impact may cause irreplaceable loss of resources		Partly irreplaceable	Partly irreplaceable	Partly irreplaceable	Partly irreplaceable
Cumulative effect prior to mitigation		Moderate negative	Moderate negative	Moderate negative	Moderate negative
Significance rating of impact prior to mitigation		Low to moderate negative	Low to moderate negative	Low negative	Low to moderate negative
Degree to which the impact can be mitigated		Partly mitigated	Partly mitigated	Partly mitigated	Partly mitigated
Cumulative effect post mitigation		Low to moderate negative	Low to moderate negative	Low to moderate negative	Low to moderate negative
Significance rating of impact after mitigation		Low	Low	Negligible to low negative	Low

Potential impacts on the freshwater ecosystems:	Alternative 1 (No-Go)	Alternative 4	Alternative 5a	Alternative 5b	Alternative 5c
Nature of impact:	**Hardening of river bank to construct gabion drop structure**				
Extent of impact:	n/a	Local area	Local area	Local area	Local area
Duration of impact		Permanent	Permanent	Permanent	Permanent
Intensity of impact		Moderate	Moderate	Moderate	Moderate
Probability of occurrence:		Definite	Definite	Definite	Definite
Degree to which the impact can be reversed		Partly reversible	Partly reversible	Partly reversible	Partly reversible
Degree to which the impact may		Partly	Partly	Partly	Partly

Potential impacts on the freshwater ecosystems:	Alternative 1 (No-Go)	Alternative 4	Alternative 5a	Alternative 5b	Alternative 5c
cause irreplaceable loss of resources		irreplaceable	irreplaceable	irreplaceable	irreplaceable
Cumulative effect prior to mitigation		Moderate negative	Moderate negative	Moderate negative	Moderate negative
Significance rating of impact prior to mitigation		Moderate negative	Moderate negative	Moderate negative	Moderate negative
Degree to which the impact can be mitigated		Partly mitigated	Partly mitigated	Partly mitigated	Partly mitigated
Cumulative effect post mitigation		Low negative	Low negative	Low negative	Low negative
Significance rating of impact after mitigation		Low negative	Low negative	Low negative	Low negative

Potential impacts on the freshwater ecosystems:	Alternative 1 (No-Go)	Alternative 4	Alternative 5a	Alternative 5b	Alternative 5c
Nature of impact:	**Pipe crossings across watercourses or water channels**				
Extent of impact:	n/a	Local area	Local area	Local area	Local area
Duration of impact		Permanent	Permanent	Permanent	Permanent
Intensity of impact		Moderate	Moderate	Moderate	Moderate
Probability of occurrence:		Definite	Definite	Definite	Definite
Degree to which the impact can be reversed		Partly reversible	Partly reversible	Partly reversible	Partly reversible
Degree to which the impact may cause irreplaceable loss of resources		Partly irreplaceable	Partly irreplaceable	Partly irreplaceable	Partly irreplaceable
Cumulative effect prior to mitigation		Moderate negative	Moderate negative	Moderate negative	Moderate negative
Significance rating of impact prior to mitigation		Moderate negative	Moderate negative	Moderate negative	Moderate negative
Degree to which the impact can be mitigated		Partly mitigated	Partly mitigated	Partly mitigated	Partly mitigated
Cumulative effect post mitigation		Low negative	Low negative	Low negative	Low negative
Significance rating of impact after mitigation		Low negative	Low negative	Low negative	Low negative

7.2.2 Construction

Potential impacts on the freshwater ecosystems:	Alternative 1 (No-Go)	Alternative 4	Alternative 5a	Alternative 5b	Alternative 5c
Nature of impact:	**Dumping of building material in sensitive areas**				
Extent of impact:	**n/a**	Site	Site	Site	Site
Duration of impact		Short-term	Short-term	Short-term	Short-term
Intensity of impact		Low	Low	Low	Low
Probability of occurrence:		Probable	Probable	Probable	Probable
Degree to which the impact can be reversed		Fully reversible	Fully reversible	Fully reversible	Fully reversible
Degree to which the impact may cause irreplaceable loss of resources		Partly replaceable	Partly replaceable	Partly replaceable	Partly replaceable
Cumulative effect prior to mitigation		Low to moderate	Low to moderate	Low to moderate	Low to moderate
Significance rating of impact prior to mitigation		Low	Low	Low	Low

Potential impacts on the freshwater ecosystems:	Alternative 1 (No-Go)	Alternative 4	Alternative 5a	Alternative 5b	Alternative 5c
Degree to which the impact can be mitigated		Fully mitigated	Fully mitigated	Fully mitigated	Fully mitigated
Cumulative effect post mitigation		Low negative to negligible	Low negative to negligible	Low negative to negligible	Low negative to negligible
Significance rating of impact after mitigation		Negligible	Negligible	Negligible	Negligible

Potential impacts on the freshwater ecosystems:	Alternative 1 (No-Go)	Alternative 4	Alternative 5a	Alternative 5b	Alternative 5c
Nature of impact:	**Pollution of the wetlands or Dwars River**				
Extent of impact:	**n/a**	Local area	Local area	Local area	Local area
Duration of impact		Medium-term	Medium-term	Medium-term	Medium-term
Intensity of impact		Moderate	Moderate	Moderate	Moderate
Probability of occurrence:		Probable	Probable	Probable	Probable
Degree to which the impact can be reversed		Partly reversible	Partly reversible	Partly reversible	Partly reversible
Degree to which the impact may cause irreplaceable loss of resources		Partly replaceable	Partly replaceable	Partly replaceable	Partly replaceable
Cumulative effect prior to mitigation		Moderate	Moderate	Moderate	Moderate
Significance rating of impact prior to mitigation		Moderate	Moderate	Moderate	Moderate
Degree to which the impact can be mitigated		Fully mitigated	Fully mitigated	Fully mitigated	Fully mitigated
Cumulative effect post mitigation		Low negative	Low negative	Low negative	Low negative
Significance rating of impact after mitigation		Low negative	Low negative	Low negative	Low negative

Potential impacts on the freshwater ecosystems:	Alternative 1 (No-Go)	Alternative 4	Alternative 5a	Alternative 5b	Alternative 5c
Nature of impact:	**Destruction or deterioration of freshwater habitat as a result of foot and vehicular traffic**				
Extent of impact:	**n/a**	Site	Site	Site	Site
Duration of impact		Short-term	Short-term	Short-term	Short-term
Intensity of impact		Low	Low	Low	Low
Probability of occurrence:		Probable	Probable	Probable	Probable
Degree to which the impact can be reversed		Fully reversible	Fully reversible	Fully reversible	Fully reversible
Degree to which the impact may cause irreplaceable loss of resources		Partly replaceable	Partly replaceable	Partly replaceable	Partly replaceable
Cumulative effect prior to mitigation		Low to moderate	Low to moderate	Low to moderate	Low to moderate
Significance rating of impact prior to mitigation		Low	Low	Low	Low
Degree to which the impact can be mitigated		Fully mitigated	Fully mitigated	Fully mitigated	Fully mitigated
Cumulative effect post mitigation		Low negative to negligible	Low negative to negligible	Low negative to negligible	Low negative to negligible
Significance rating of impact after mitigation		Negligible	Negligible	Negligible	Negligible

Potential impacts on the freshwater ecosystems:	Alternative 1 (No-Go)	Alternative 4	Alternative 5a	Alternative 5b	Alternative 5c
Nature of impact:	**Excavation and/or infilling of wetlands or floodplain**				
Extent of impact:	**n/a**	Local area	Local area	Local area	Local area
Duration of impact		Medium-term	Medium-term	Medium-term	Medium-term
Intensity of impact		Moderate	Moderate	Moderate	Moderate
Probability of occurrence:		Probable	Probable	Probable	Probable
Degree to which the impact can be reversed		Partly reversible	Partly reversible	Partly reversible	Partly reversible
Degree to which the impact may cause irreplaceable loss of resources		Partly replaceable	Partly replaceable	Partly replaceable	Partly replaceable
Cumulative effect prior to mitigation		Moderate negative	Moderate negative	Moderate negative	Moderate negative
Significance rating of impact prior to mitigation		Moderate negative	Moderate negative	Moderate negative	Moderate negative
Degree to which the impact can be mitigated		Fully mitigated	Fully mitigated	Fully mitigated	Fully mitigated
Cumulative effect post mitigation		Low negative	Low negative	Low negative	Low negative
Significance rating of impact after mitigation		Low negative	Low negative	Low negative	Low negative

Potential impacts on the freshwater ecosystems:	Alternative 1 (No-Go)	Alternative 4	Alternative 5a	Alternative 5b	Alternative 5c
Nature of impact:	**Disturbance of freshwater fauna and flora**				
Extent of impact:	**n/a**	Local area	Local area	Local area	Local area
Duration of impact		Short-term	Short-term	Short-term	Short-term
Intensity of impact		Low	Low	Low	Low
Probability of occurrence:		Definite	Definite	Definite	Definite
Degree to which the impact can be reversed		Fully reversible	Fully reversible	Fully reversible	Fully reversible
Degree to which the impact may cause irreplaceable loss of resources		Partly replaceable	Partly replaceable	Partly replaceable	Partly replaceable
Cumulative effect prior to mitigation		Moderate negative	Moderate negative	Moderate negative	Moderate negative
Significance rating of impact prior to mitigation		Low negative	Low negative	Low negative	Low negative
Degree to which the impact can be mitigated		Partly mitigated	Partly mitigated	Partly mitigated	Partly mitigated
Cumulative effect post mitigation		Low negative	Low negative	Low negative	Low negative
Significance rating of impact after mitigation		Negligible	Negligible	Negligible	Negligible

Potential impacts on the freshwater ecosystems:	Alternative 1 (No-Go)	Alternative 4	Alternative 5a	Alternative 5b	Alternative 5c
Nature of impact:	**Increased input of sediments**				
Extent of impact:	**n/a**	Local area	Local area	Local area	Local area
Duration of impact		Medium-term	Medium-term	Medium-term	Medium-term
Intensity of impact		Moderate	Moderate	Moderate	Moderate
Probability of occurrence:		Probable	Probable	Probable	Probable

Potential impacts on the freshwater ecosystems:	Alternative 1 (No-Go)	Alternative 4	Alternative 5a	Alternative 5b	Alternative 5c
Degree to which the impact can be reversed		Partly reversible	Partly reversible	Partly reversible	Partly reversible
Degree to which the impact may cause irreplaceable loss of resources		Partly replaceable	Partly replaceable	Partly replaceable	Partly replaceable
Cumulative effect prior to mitigation		Moderate	Moderate	Moderate	Moderate
Significance rating of impact prior to mitigation		Moderate	Moderate	Moderate	Moderate
Degree to which the impact can be mitigated		Fully mitigated	Fully mitigated	Fully mitigated	Fully mitigated
Cumulative effect post mitigation		Low negative	Low negative	Low negative	Low negative
Significance rating of impact after mitigation		Low negative	Low negative	Low negative	Low negative

Potential impacts on the freshwater ecosystems:	Alternative 1 (No-Go)	Alternative 4	Alternative 5a	Alternative 5b	Alternative 5c
Nature of impact:	**Introduction and spread of invasive alien plants**				
Extent of impact:	**n/a**	Local area	Local area	Local area	Local area
Duration of impact		Medium-term	Medium-term	Medium-term	Medium-term
Intensity of impact		Moderate	Moderate	Moderate	Moderate
Probability of occurrence:		Highly probable	Highly probable	Highly probable	Highly probable
Degree to which the impact can be reversed		Fully reversible	Fully reversible	Fully reversible	Fully reversible
Degree to which the impact may cause irreplaceable loss of resources		Partly replaceable	Partly replaceable	Partly replaceable	Partly replaceable
Cumulative effect prior to mitigation		Moderate to high	Moderate to high	Moderate to high	Moderate to high
Significance rating of impact prior to mitigation		Moderate	Moderate	Moderate	Moderate
Degree to which the impact can be mitigated		Fully mitigated	Fully mitigated	Fully mitigated	Fully mitigated
Cumulative effect post mitigation		Low negative	Low negative	Low negative	Low negative
Significance rating of impact after mitigation		Low negative	Low negative	Low negative	Low negative

7.2.3 Operational

Potential impacts on the freshwater ecosystems:	Alternative 1 (No-Go)	Alternative 4	Alternative 5a	Alternative 5b	Alternative 5c
Nature of impact:	**Increased water demand and water supply infrastructure**				
Extent of impact:	**n/a**	Regional	Regional	Regional	Regional
Duration of impact		Permanent	Permanent	Permanent	Permanent
Intensity of impact		Moderate	Moderate	Moderate	Moderate
Probability of occurrence:		Definite	Definite	Definite	Definite
Degree to which the impact can be reversed		Party reversible	Party reversible	Party reversible	Party reversible
Degree to which the impact may cause irreplaceable loss of resources		Irreplaceable	Irreplaceable	Irreplaceable	Irreplaceable
Cumulative effect prior to		High negative	High negative	High negative	High negative

Potential impacts on the freshwater ecosystems:	Alternative 1 (No-Go)	Alternative 4	Alternative 5a	Alternative 5b	Alternative 5c
mitigation					
Significance rating of impact prior to mitigation		Low negative	Low negative	Low negative	Low negative
Degree to which the impact can be mitigated		Partly mitigated	Partly mitigated	Partly mitigated	Partly mitigated
Cumulative effect post mitigation		Low to moderate negative	Low to moderate negative	Low to moderate negative	Low to moderate negative
Significance rating of impact after mitigation		Negligible to low negative	Negligible to low negative	Negligible to low negative	Negligible to low negative

Potential impacts on the freshwater ecosystems:	Alternative 1 (No-Go)	Alternative 4	Alternative 5a	Alternative 5b	Alternative 5c
Nature of impact:	**Decrease in water quality**				
Extent of impact:	Regional	Regional	Regional	Regional	Regional
Duration of impact	Permanent	Permanent	Permanent	Permanent	Permanent
Intensity of impact	Low	Moderate	Moderate	Moderate	Moderate
Probability of occurrence:	Definite	Definite	Definite	Definite	Definite
Degree to which the impact can be reversed	Fully reversible	Fully reversible	Fully reversible	Fully reversible	Fully reversible
Degree to which the impact may cause irreplaceable loss of resources	Irreplaceable	Irreplaceable	Irreplaceable	Irreplaceable	Irreplaceable
Cumulative effect prior to mitigation	High negative	High negative	High negative	High negative	High negative
Significance rating of impact prior to mitigation	Low negative	Moderate negative	Moderate negative	Moderate negative	Moderate negative
Degree to which the impact can be mitigated	Partly mitigated	Partly mitigated	Partly mitigated	Partly mitigated	Partly mitigated
Cumulative effect post mitigation	n/a	Moderate negative	Moderate negative	Moderate negative	Moderate negative
Significance rating of impact after mitigation	n/a	Low to moderate negative	Low to moderate negative	Low to moderate negative	Low to moderate negative

Potential impacts on the freshwater ecosystems:	Alternative 1 (No-Go)	Alternative 4	Alternative 5a	Alternative 5b	Alternative 5c
Nature of impact:	**Increase in water quantity**				
Extent of impact:	n/a	Regional	Regional	Regional	Regional
Duration of impact		Permanent	Permanent	Permanent	Permanent
Intensity of impact		High	High	High	High
Probability of occurrence:		Definite	Definite	Definite	Definite
Degree to which the impact can be reversed		Party reversible	Party reversible	Party reversible	Party reversible
Degree to which the impact may cause irreplaceable loss of resources		Irreplaceable	Irreplaceable	Irreplaceable	Irreplaceable
Cumulative effect prior to mitigation		High negative	High negative	High negative	High negative
Significance rating of impact prior to mitigation		Moderate negative	Moderate negative	Moderate negative	Moderate negative
Degree to which the impact		Partly mitigated	Partly mitigated	Partly mitigated	Partly mitigated

Potential impacts on the freshwater ecosystems:	Alternative 1 (No-Go)	Alternative 4	Alternative 5a	Alternative 5b	Alternative 5c
can be mitigated					
Cumulative effect post mitigation		Low to moderate negative	Low to moderate negative	Low to moderate negative	Low to moderate negative
Significance rating of impact after mitigation		Low negative	Low negative	Low negative	Low negative

Potential impacts on the freshwater ecosystems:	Alternative 1 (No-Go)	Alternative 4	Alternative 5a	Alternative 5b	Alternative 5c
Nature of impact:	**Disturbance of fauna and flora**				
Extent of impact:	Local area	Local area	Local area	Local area	Local area
Duration of impact	Permanent	Permanent	Permanent	Permanent	Permanent
Intensity of impact	Low	Low	Low	Low	Low
Probability of occurrence:	Probable	Definite	Definite	Definite	Definite
Degree to which the impact can be reversed	Fully reversible	Fully reversible	Fully reversible	Fully reversible	Fully reversible
Degree to which the impact may cause irreplaceable loss of resources	Partly replaceable	Partly replaceable	Partly replaceable	Partly replaceable	Partly replaceable
Cumulative effect prior to mitigation	Moderate negative	Moderate negative	Moderate negative	Moderate negative	Moderate negative
Significance rating of impact prior to mitigation	Low negative to negligible	Low negative	Low negative	Low negative	Low negative
Degree to which the impact can be mitigated	Partly mitigated	Partly mitigated	Partly mitigated	Partly mitigated	Partly mitigated
Cumulative effect post mitigation	n/a	Low negative	Low negative	Low negative	Low negative
Significance rating of impact after mitigation	n/a	Negligible	Negligible	Negligible	Negligible

Potential impacts on the freshwater ecosystems:	Alternative 1 (No-Go)	Alternative 4	Alternative 5a	Alternative 5b	Alternative 5c
Nature of impact:	**Spread and establishment of invasive alien plants**				
Extent of impact:	Local area	Local area	Local area	Local area	Local area
Duration of impact	Long-term	Short-term	Short-term	Short-term	Short-term
Intensity of impact	Low	Low	Low	Low	Low
Probability of occurrence:	Probable	Probable	Probable	Probable	Probable
Degree to which the impact can be reversed	Fully reversible	Fully reversible	Fully reversible	Fully reversible	Fully reversible
Degree to which the impact may cause irreplaceable loss of resources	Partly replaceable	Partly replaceable	Partly replaceable	Partly replaceable	Partly replaceable
Cumulative effect prior to mitigation	Moderate negative	Moderate negative	Moderate negative	Moderate negative	Moderate negative
Significance rating of impact prior to mitigation	Low negative to negligible	Low negative	Low negative	Low negative	Low negative
Degree to which the impact can be mitigated	Partly mitigated	Partly mitigated	Partly mitigated	Partly mitigated	Partly mitigated
Cumulative effect post mitigation	Low negative	Low negative	Low negative	Low negative	Low negative
Significance rating of impact after mitigation	Negligible	Negligible	Negligible	Negligible	Negligible

8 Conclusions

- The freshwater ecosystems affected by the proposed Boschendal Village development include three hillslope seep wetlands and one depression (on site) and the Dwars River (adjacent to site, but affected by services), and five small watercourses (channels < 5m across) located off-site between the proposed site and Pniel (these would be impacted by the water supply mains and the sewer pipeline).
- Wetlands 1 and 2 are located near the south-eastern corner of the site, and are probably two parts of the same wetland, on either side of a dirt road bisecting this area. The wetlands are both dominated by the riverbed grass, *Pennisetum macrourum*. This species is an indicator of temporary to seasonal wetness. Wetland 3 is a small, isolated patch of *P. macrourum*, which may have been created from a past excavation. Wetland 4 is a linear wetland that is adjacent to the railway line. While this area may always have been seasonal wetland, the shape and location of the wetland area is probably influenced by the obstruction to subsurface and surface flow presented by the railway line, and the surrounding buildings. This wetland is also dominated by *P. macrourum.*
- It is most likely that the wetlands are fed naturally primarily by subsurface (i.e. interflow) water and groundwater, rather than surface water. The sandy soils on the site are well-drained and dispersive, with considerable absorptive capacity, leading to the lack of natural surface channels, and occurrence of seep wetlands. The localised water table is higher in winter, pushing water to the surface and creating / sustaining seepage wetlands. This water daylights (surfaces) where there is a change in topography – this occurs along the outer edge of the Dwars River floodplain, i.e. the gentle surrounding slopes meet the flatter floodplain, and the subsurface water surfaces. Surface water draining into and through the wetlands by virtue of the agricultural channels will add to this water supply, but this is unlikely to sustain the wetlands through the dry summer months.
- Wetland 3 is probably an exception to this – this wetland may have been created through excavation of soil in this area, and may be filled via rainfall and surface runoff, rather than subsurface water.
- A desktop, expert-reviewed assessment of the present ecological status (PES) of the Dwars River gave the result as a category C or moderately modified. This matched an earlier ground-truthed assessment done on a reach of the Dwars River slightly further upstream. The river has a high ecological importance and a very high ecological sensitivity.
- The wetlands were found to be fairly heavily impacted by the surrounding agricultural activities, roads and the railway line. Wetland 1 lies in a category C in terms of PES, while the other three wetlands are in poorer condition. The wetlands are all of moderate ecological importance and sensitivity, with wetland 3 being the least important due to its probable anthropogenic origin. The wetlands could provide functional (both in terms of biodiversity and ecological processes, primarily related to infiltration of water) value to the development, if conserved in an ecological corridor.
- In order to reduce the impacts associated with the **development layout**:
    - All sensitive ecosystems should be allowed a development setback or buffer, in order to provide some protection from the impacts of the development. It is recommended that a 10 m buffer be allowed around wetlands 2, 3 and 4, and a 30 m buffer around wetland 1. This has been achieved for all development options.
    - Allow for an ecological corridor to connect all of the wetlands, and then preferably with a connection to the Dwars River and its floodplain (i.e. connect with the 1:100 year floodline, below which no development should occur). This has been partly achieved for all development options, however Alternative 5b achieves greater connectivity with the floodplain, as the houses have been kept above the existing 1:100 year floodline, and no fill is required in the floodplain.
    - Roads and services should preferably not cross over the wetlands or watercourses but rather go around them, leading to minimal fragmentation of these ecosystems. All development alternatives avoid the need to cross over the wetlands and Dwars River,

however, future development in the area will require a sewage pipeline across the Dwars River. This is considered a cumulative future impact. Should this become necessary, the pipeline must be attached to the existing Dwars River bridge.

- All development alternatives will require water mains and sewer pipelines running from Pniel to the proposed development. The pipes will cross over at least four natural stream channels, and a number of ditches. Crossings should be constructed using thrust-boring (i.e. directional drilling) and avoiding the riparian zone wherever possible, in order to minimise impacts on flow and on the bed and banks of the watercourses.
- All development alternatives require the construction of a gabion drop structure at the outlet of the stormwater pipe exiting the site. This will have a low residual negative impact as this impact can only partly be mitigated. Most importantly, the size of the structure must be minimized, and the structure must be kept out of the active channel.
- All development alternatives will also require the construction of a sewage pump station below the 1:100 year floodline of the Dwars River.

- The **construction** phase must be guided by a detailed construction EMPr, which must include the mitigation measures recommended in this report.
- The main impacts associated with the **operational** phase relate to increased water use in the area, and the reduced water quality and increased water quantity that comes with the generation of on-site stormwater and the risk of pollution from the sewer pipeline from the site to the Pniel WWTW. These impacts are of particular importance here, as the Berg River catchment is a water-stressed catchment, and the Berg River is a listed resource, so discharge of water into its tributary the Dwars River is subject to Special Limits, rather than General Limits. In addition, a sewage pump station is proposed to be located below the 1:100 year floodline. While this will have some residual negative impact on the river, and pose the risk of pollution entering the river, this is preferable to the need to construct pipes over the Dwars River. Despite its impact, this is acceptable from a freshwater ecological perspective.
- In order to reduce these impacts, the following actions are recommended:
  - Water demand management must be implemented within the development, a specified in the Provincial and Stellenbosch Municipality SDFs (see Section 4). Rainwater storage tanks should be built on every erf.
  - Care must be taken in the location of water supply infrastructure, in order to avoid sensitive areas.
  - Effort should be made to minimise the hardening of surfaces. Natural areas, gardens and road verges are areas where water can filter into the ground. The predominantly sandy soils of the site will allow this to occur.
  - Stormwater should be allowed to flow along unlined channels before discharge into either natural or created wetland areas. Wetland 4 can be used for stormwater detention. This will allow some infiltration of water into the ground, so reducing the quantity of runoff and improving the quality.
  - Parking areas should preferably be constructed of permeable materials to allow for infiltration of water.
  - As a principle, hardened areas should be associated (where possible) with vegetated filter strips (broad, sloped vegetated areas that accept shallow runoff from hardened surfaces), bioswales (landscaped areas that are designed to remove silt and a number of pollutants from runoff, through ensuring that water flows slowly along these gently sloping (<6% slope) features, often planted with grass or other plant species, mulch or riprap), and / or bio-retention systems (vegetated areas where runoff is filtered through a filter media layer, e.g. sand, as it percolates downwards), all of which are designed to reduce the quantity of runoff leaving a hardened surface and entering the stormwater system.

  - The sewer pipeline route must be checked monthly for leaks and for overflowing manholes. Leaks must be fixed immediately.

- From a freshwater ecological perspective, there are fewer impacts associated with Alternative 1, the status quo, and this is thus the preferred alternative. The wetlands on the site are being maintained by current runoff, and support some wetland plants and probably animals. The Dwars River floodplain is cultivated to some extent, and there is polluted runoff entering the river from current activities on the site, however these are all of lesser negative significance compared with any of the development options. Given the development pressures of the area, the likelihood of the site remaining as is, however, is relatively low.
- From a freshwater ecological perspective, the preferred *development* option is Alternative 5b, as this option will lead to less fragmentation of the landscape, and of the connectivity between the wetlands on the site and the Dwars River floodplain. The difference between this option and the others is marginal and generally does not translate into a shift in the significance of impacts, apart from those associated with the layout – loss of open space, and loss of floodplain area – where the significance could be lowered to negligible, with effective implementation of the recommended mitigation measures.

9 References

DWAF, 1999. Resource Directed Measures for Protection of Water Resources. Volume 3: River Ecosystems Version 1.0, Pretoria. Resource Directed Measures for Protection of Water Resources, Pretoria, South Africa.

DWS. 2014. A Desktop Assessment of the Present Ecological State, Ecological Importance and Ecological Sensitivity per Sub Quaternary Reaches for Secondary Catchments in South Africa. Secondary: G1. Compiled by RQIS-RDM: https://www.dwaf.gov.za/iwqs/rhp/eco/peseismodel.aspx accessed on 24th March 2015.

Helme, N. 2015. Comment on revised, proposed layout for Boschendal Village development. Letter written to Doug Jeffery Environmental Consultants, 6 March 2015.

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

Kleynhans, CJ, Thirion, C and Moolman, J. 2005. A Level I River Ecoregion classification system for South Africa, Lesotho and Swaziland. Report No. N/0000/00/REQ0104.

Kotze DC, Marneweck GC, Batchelor, AL, Lindley DS and Collins NB, 2007. WET-EcoServices: A technique for rapidly assessing ecosystem services supplied by wetlands. WRC Report No TT 339/08, Water Research Commission, Pretoria.

Macfarlane DM, Kotze DC, Ellery WN, Walters D, Koopman V, Goodman P and Goge C. 2007. WET-Health: A technique for rapidly assessing wetland health. WRC Report No TT 340/08, Water Research Commission, Pretoria.

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

Mucina, L., Rutherford, M.C. and Powrie, L.W. (eds) 2007. Vegetation Map of South Africa, Lesotho and Swaziland, edn 2, 1:1 000 000 scale sheet maps. South African National Biodiversity Institute, Pretoria. ISBN 978-1-919976-42-6.

Parsons, R. 2010. Groundwater assessment of the Pniel WWTW. Report number 277/PNI-D1. Submitted to Boschendal (Pty) Ltd, May 2010, 11pp.

Rebelo, A.G., Boucher, C., Helme, N., Mucina, L. and Rutherford, M.C. 2006. Fynbos Biome. In Mucina, L. And Rutherford, M.C. (eds.). The vegetation of South Africa, Lesotho and Swaziland. Strelitzia 19: 52 – 219).

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

Resource Quality Services, Department of Water Affairs and Forestry, Pretoria, South Africa.Snaddon, K. 2007. Wetland and river assessment for the proposed development at Boschendal Estate: Baseline study. Report prepared for Doug Jeffery Environmental Consultants, April 2007.

Snaddon, K. 2007. Wetland and river assessment for the proposed development at Boschendal Estate: Baseline study. Report prepared for Doug Jeffery Environmental Consultants, April 2007.

Snaddon, K. 2010. Environmental Impact Assessment of the proposed upgrade of the Waste Water Treatment Works, Pniel: Freshwater Ecosystems. Report submitted to Doug Jeffery Environmental Consultants, August 2010.

Southern Waters, 2001. Field Guide to Present Ecological Status Scores. Western Cape Rivers. A Southern Waters Information Report, 01/01.

Appendix 1: Risk assessment matrix