Aquatic Biodiversity Impact Assessment Addendum

Stormwater Management and WWTW Expansion: Clanwilliam Housing Development, Remainder Erf 279, Clanwilliam, Western Cape

For: Enviro EAP

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DELTA ECOLOGY

Report Information

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Executive Summary

Delta Ecology was appointed to provide additional aquatic specialist input for the Clanwilliam Housing Development on Remainder Erf 279, Clanwilliam. This addendum supplements the Enviro-EAP (2026) Aquatic Biodiversity Impact Assessment. It responds to DEA&DP and CapeNature comments on the proposed stormwater infrastructure and the refurbishment and expansion of the Clanwilliam WWTW, and should be read with that report and the EnviroSwift (2025) peer review.

A site assessment was undertaken on 29 September 2026, at the end of the wet season. The central valley-bottom wetland system (Wetlands 1 and 2 in previous assessments) is seriously modified (PES E), receiving stormwater from the existing informal settlement and township and affected by the golf course, and is of Moderate ecological importance and sensitivity. The Jan Dissels River was flowing both upstream and downstream of the WWTW and is largely modified (PES D) and of Very High ecological importance and sensitivity. Treated effluent is released below the golf course into a dense *Phragmites australis* and *Typha capensis* reed bed associated with a seep (referred to as southern seep) that drains to the river (**Table i**). The Jan Dissels and Olifants River floodplain wetlands are largely modified (PES D) and of Very High ecological importance and sensitivity, the southern seep, which is sustained by treated effluent, is seriously modified (PES E), and the two historic non-perennial tributaries of the Jan Dissels River are seriously to critically modified (IHI E/F) with no ecological importance or sensitivity. Downstream of the works the river is strongly influenced by treated effluent, with ammonia above the chronic toxicity threshold for aquatic life, eutrophic nitrogen levels and increased E. coli.

Table i: Results of the watercourse status quo assessment.

	PES / IHI	Ecosystem Services (ES)	EIS	REC
Central valley bottom	E	Moderately Low	Moderate	D (through the Rehabilitation Plan)
Southern Seep	E	Moderate – Moderately High	Moderate	Not set; maintain present state
Jan Dissels River & floodplain wetland	D	Very High	Very High	C
Olifants River & floodplain wetland	D	Very High	Very High	C
Historic non-perennial tributaries	E/F (instream), F (riparian)	None	None	D (central, associated with the central wetland system rehabilitation); not practical (southern)

The stormwater infrastructure, comprising 21 headwalls, four attenuation ponds and a piped connection within the central valley-bottom wetland system, and the refurbishment and expansion of the WWTW, with a new 1.5 Ml/day module and the upgraded works intended to treat at least 3.6 Ml/day at peak, were assessed. With mitigation, the construction impacts and the operational impacts of the stormwater system are of Low significance. Combined with the Wetland Rehabilitation and Management Plan (Delta Ecology, 2026), the stormwater design offers an opportunity to improve the central wetland, which currently receives untreated stormwater from the informal settlement and township.

The quality of treated effluent in the Jan Dissels River, which is of High significance before mitigation, and the change in flow in the river from the full expansion of the works remain of Medium significance after mitigation. The change in flow from the housing development's own effluent is of Low significance after mitigation, as the volume is small, regulated by the southern seep, and partly reused for irrigation, and the impacts on the southern seep are of Low significance, given the degree of disturbance it already exhibits (hydrology and water quality critically modified, PES E). This reflects the long history of non-compliance at the works, the absence of a water balance and the precautionary approach adopted. Impacts on the Olifants River, about 4.7 km downstream of the effluent release, are of Low significance after mitigation.

The DWS Risk Assessment Matrix (RAM) (GN 4167 of 2023) mirrors the impact assessment. The effluent quality in the Jan Dissels River and the change in flow from the full expansion of the works are of Moderate risk, and all other activities are of Low risk. A full Water Use Licence Application is therefore required for the section 21 (c) and 21 (i) water uses, in addition to the section 21 (e) and 21 (f) uses for the irrigation and discharge of treated effluent.

It is the opinion of the specialist that the development, including its stormwater infrastructure and the refurbishment and expansion of the WWTW, is acceptable from an aquatic biodiversity perspective and may be authorised, provided that the mitigation measures are implemented and the upgraded works consistently meets the Special Limit Values for discharge to the Jan Dissels River. The development will formalise housing for residents of the existing informal settlement, and the refurbishment of the WWTW is necessary; both offer an opportunity to improve the quality of water reaching the river. Careful implementation of the recommended mitigation, monitoring and oversight is essential.

The key conditions are compliance with the Special Limit Values under specialist oversight, a full WULA with a water balance for the works, attenuation and treatment of stormwater, implementation of the Wetland Rehabilitation and Management Plan, an irrigation management plan for the golf course, and a monitoring plan, with SASS5 and fish baseline surveys before construction.

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Robyn Morton has a MSc. degree in Conservation Sciences from the Cape Peninsula University of Technology. Throughout her studies, internships, and consultancy experience, she has gained valuable and informed insight into the functioning of natural and socio-ecological systems, as well as many key research and monitoring skills. Prior to her consulting career, Robyn worked for Zandvlei Estuary Nature Reserve for 4 years and gained experience in the field of urban wetland and estuary management. Robyn specialises in aquatic ecology and is currently working for Delta Ecology as a junior associate under the guidance of Kimberley van Zyl.

A signed statement of independence will be provided as a separate document.

1. Introduction

Delta Ecology was appointed to provide additional specialist aquatic ecological input for the proposed Clanwilliam Housing Development and associated expansion of the existing Clanwilliam Wastewater Treatment Works (WWTW), located on and adjacent to Remainder Erf 279, Clanwilliam.

The proposed development includes two housing development areas and associated municipal infrastructure, together with the refurbishment and expansion of the existing Clanwilliam WWTW. The WWTW expansion is required to provide additional wastewater treatment capacity associated with the proposed development and broader servicing requirements within Clanwilliam over the next 15 years. A large portion of the treated effluent from the existing WWTW is currently used for irrigation of the adjacent golf course, with the remainder discharged to the Jan Dissels River (BVi Consulting Engineers, 2024).

The site lies on the eastern edge of Clanwilliam, between the town and the Jan Dissels River, in quaternary catchment E10H (**Figure 1-1**).

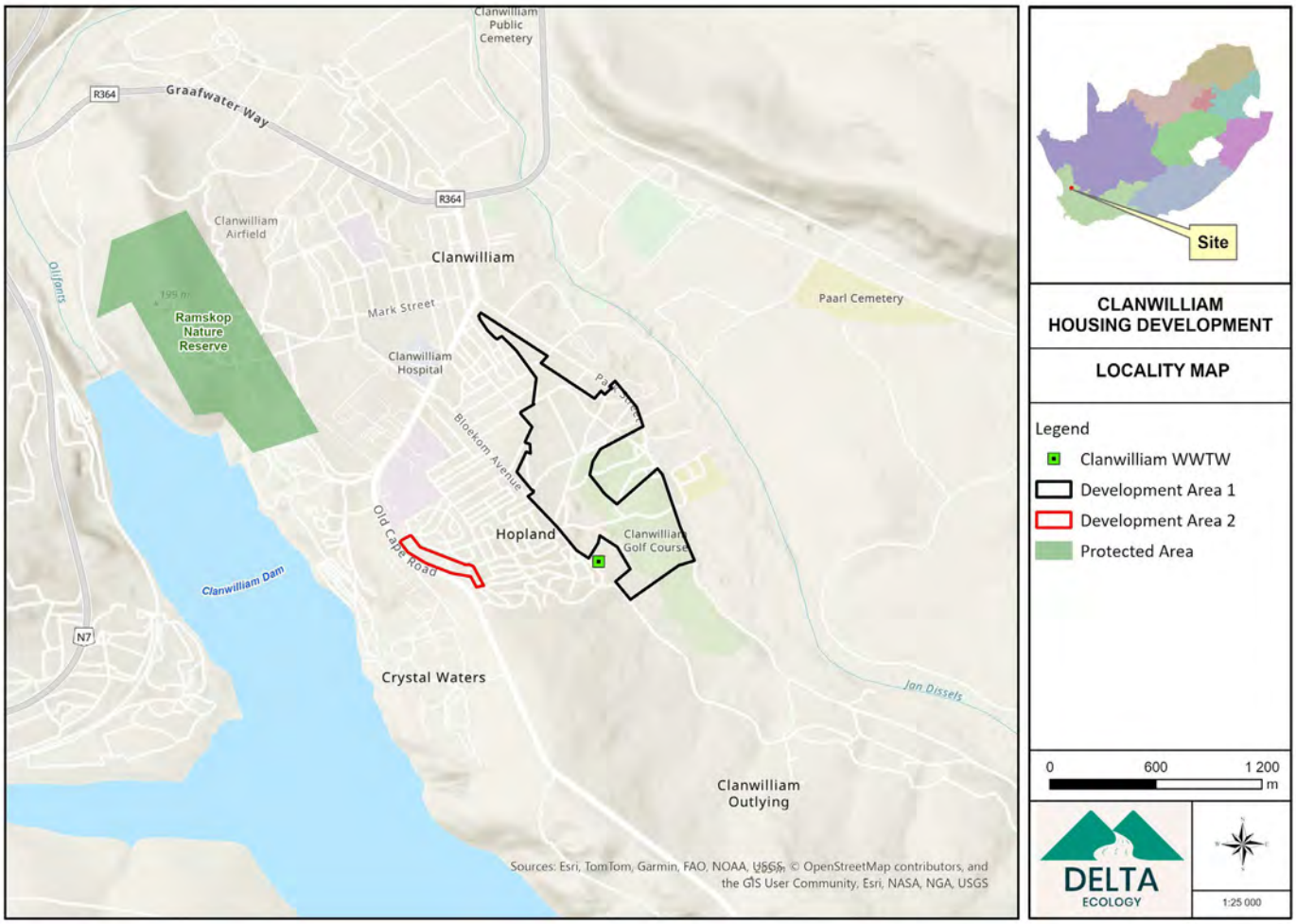


Figure 1-1: Locality of the Clanwilliam Housing Development areas and the WWTW.

Aquatic biodiversity assessments have previously been undertaken for the proposed development by Enviro-EAP Environmental Consultants (Enviro-EAP, 2025; 2026), with the assessment independently peer reviewed by EnviroSwift Western Cape (EnviroSwift, 2025). Following review of the aquatic specialist information by the relevant commenting authorities, a number of matters were identified as requiring further specialist consideration.

This report therefore provides an addendum to the existing Aquatic Biodiversity Impact Assessment and focuses specifically on these outstanding aquatic biodiversity matters. It should be read together with the Enviro-EAP (2026) Aquatic Biodiversity Impact Assessment, the EnviroSwift (2025) peer review and the relevant engineering information relating to the proposed WWTW refurbishment and expansion. The background to the assessment process and the specific matters addressed in this addendum are provided below.

1.1. Background

Enviro-EAP Environmental Consultants previously compiled an Aquatic Biodiversity Impact Assessment for the proposed Clanwilliam Housing Development and expansion of the existing Clanwilliam WWTW on a portion of Remainder Erf 279, Clanwilliam (Enviro-EAP, 2025; 2026). The assessment considered the freshwater features associated with the proposed development, as well as potential impacts associated with the housing development, associated infrastructure and expansion of the existing WWTW.

The Aquatic Biodiversity Impact Assessment was subsequently subject to an independent specialist peer review undertaken by EnviroSwift Western Cape (EnviroSwift, 2025). The peer review included a site assessment undertaken on 26 September 2025 and provided additional findings regarding the classification, extent and ecological importance of the freshwater features occurring within and downstream of the proposed development area. In particular, EnviroSwift (2025) identified the freshwater feature traversing the central portion of the site and extending towards the Jan Dissels River as an unchannelled valley-bottom wetland, rather than a non-perennial drainage line, and recommended that subsequent detailed ecological and impact/risk assessments focus on this wetland system.

Enviro-EAP subsequently revised the Aquatic Biodiversity Impact Assessment, with the April 2026 version incorporating findings and recommendations arising from the EnviroSwift peer review (Enviro-EAP, 2026). This included, amongst other measures, provision for a 15 m wetland buffer, amendments to the development layout to avoid infrastructure within portions of the downstream wetland, and rehabilitation and stormwater-management measures intended to protect the wetland system.

Following review of the revised assessment, the Western Cape Department of Environmental Affairs and Development Planning (DEA&DP) and CapeNature requested additional information relating to specific aspects of the proposed development. The outstanding matters relate primarily to the integration and management of the wetland system within the proposed development, the proposed stormwater infrastructure, and the potential aquatic impacts associated with the expansion and operation of the Clanwilliam WWTW. In particular, further consideration was requested regarding the potential effects of the stormwater system on the receiving wetland environment, the quality and quantity of treated effluent discharged from the WWTW, and the potential effects of this discharge on the Jan Dissels River.

The existing Clanwilliam WWTW is currently subject to capacity and operational constraints. The engineering Technical Report prepared for the refurbishment and upgrade of the WWTW records deficiencies in several components of the existing treatment process and confirms that a large proportion of the treated effluent is used for irrigation of the adjacent golf course, while the remaining effluent is discharged via a gravity pipeline to the Jan Dissels River approximately 350 m south-east of the WWTW (BVi Consulting Engineers, 2024). The proposed refurbishment and expansion of the WWTW therefore requires consideration not only in terms of increased treatment capacity, but also in terms of the implications for treated-effluent quality, discharge volumes and the receiving aquatic environment.

This Aquatic Biodiversity Addendum has therefore been prepared to address these outstanding matters and supplement, rather than replace, the existing Aquatic Biodiversity Impact Assessment (Enviro-EAP, 2026). The previous aquatic assessment and findings of the independent EnviroSwift (2025) peer review provide the basis for the addendum, where applicable.

The addendum specifically considers:

- the proposed stormwater-management infrastructure and potential effects of stormwater discharge on the retained unchannelled valley-bottom wetland system;
- infrastructure and the maintenance of hydrological connectivity between the identified wetland areas;
- the proposed refurbishment and expansion of the Clanwilliam WWTW, with particular consideration of the existing treatment constraints and proposed upgrades;
- the potential aquatic implications of treated-effluent quality and any increase in the volume of treated effluent discharged to the Jan Dissels River;
- potential impacts of the above activities on the receiving wetland and river environment; and
- appropriate mitigation, management and monitoring measures required to minimise impacts on the freshwater environment.

1.2. Comments Addressed in this Addendum

Table 1-1 lists the DEA&DP and CapeNature comments that this addendum responds to. The remaining aquatic comments (DEA&DP 2.3.1 to 2.3.7) relate to the classification, delineation and assessment of the wetland and to the peer review, and are addressed by the EAP with reference to Enviro-EAP (2026) and EnviroSwift (2025).

Table 1-1: DEA&DP and CapeNature comments addressed in this addendum.

Ref.	Comment (summarised)	Response and section
DEA&DP 2.3.7.1	Hard infrastructure is proposed between Wetland 1 and Wetland 2 (within the wetland system), and its impacts have not been assessed.	The stormwater infrastructure within and between Wetlands 1 and 2, including the piped connection, headwalls and detention pond, is assessed in Section 5.1, with mitigation in Section 6.1.
DEA&DP 2.3.8 and 2.3.8.1	The statement that the development will not affect water quality, provided the WWTW effluent meets the parameters, is not supported by evidence. The effluent has not complied with the General Limit Values (DWS, 11 April 2025).	Provides the evidence for the EAP's response: the WWTW compliance record (BVi, 2024) and water quality results for the Jan Dissels River upstream and downstream of the effluent release (Section 4.6), assessed in Section 5.2.
DEA&DP 2.3.9	The impacts of the WWTW expansion are not assessed, and the mitigation is not supported by empirical data on the Jan Dissels River and the effluent.	The WWTW refurbishment and expansion are assessed in Section 5.2, using the water quality data in Section 4.6.
DEA&DP 2.3.9.1	The statement "Upgrading and expanding the WWTW will ensure compliance with Special Limit Value standards" is referenced.	The upgrade's design targets are described in Section 2.2. Compliance is treated as a design objective that depends on operation and maintenance, and effluent monitoring is recommended (Sections 5.2 and 6).
DEA&DP 2.3.9.2	The assessment does not explain how the expansion will improve effluent quality, or address the impacts of the	The process upgrades are described in Section 2.2 and the effect of the increased discharge on the Jan Dissels River is assessed in Section 5.2. *No water balance was available, so the*

	increased effluent volume discharged to the Jan Dissels River.	*increased discharge is assessed as a conservative upper-bound scenario.*
DEA&DP 2.3.9.3	The claims that irrigation will filter ammonia, suspended solids and COD are not substantiated.	Reviewed in Section 5.2. Irrigation is not relied on as mitigation, and irrigation management measures are recommended in Section 6.2.
DEA&DP 2.3.10 and 2.3.11	The specialist must address the peer review shortcomings, and an updated assessment should cover the integration of the wetland into the design and the impacts of the WWTW expansion and discharge.	This addendum addresses the stormwater and WWTW aspects (Sections 5 and 6). Integration of the wetland into the stormwater design is addressed in Sections 5.1 and 6.1.
DEA&DP 2.3.12	The assessment must include the potential impacts of the stormwater system on the receiving freshwater environment.	Provided in this addendum (Section 5.1), rather than as a revision of Enviro-EAP (2026), at the EAP's request.
CapeNature	Provide a rehabilitation plan for the wetlands, to be implemented as part of the EMPr.	Provided as a separate Wetland Rehabilitation and Management Plan (Delta Ecology, 2026).

1.3. Scope and Limitations

This addendum covers the stormwater infrastructure and the WWTW refurbishment and expansion only. The housing development, the desktop context and the wetland buffers are addressed in Enviro-EAP (2026) and EnviroSwift (2025) and are not repeated. The receiving watercourses are re-assessed in Section 4 to provide the baseline for the stormwater and WWTW impacts. The main limitations are:

- A single site visit on 29 September 2026, at the end of the wet season, and a single water quality sampling event. Neither covers low-flow conditions in late summer, when the influence of the effluent is likely to be greatest.
- Hydrological modelling and the calculation of flows in the Jan Dissels River are outside the scope of this assessment. No water balance for the upgraded WWTW or flow data for the river were available, so the effect of the increased effluent volume on the flow regime of the Jan Dissels River has been assessed as a conservative upper-bound scenario. If DWS recommend a hydrological assessment for the expansion of the WWTW, this report may need to be updated.
- The stormwater aspect is based on the network layout and pond summary provided at the time of the assessment (UDS Africa, 2026b). The findings may need to be revisited if outlet positions or the pond design change materially.
- The assessment relies on the engineering information provided (BVi, 2024). Review of the WWTW process design is outside the scope.

2. Project Components Assessed

2.1. Stormwater Management

The housing development comprises about 1 277 residential erven in two projects, the Clanwilliam Housing IRDP (Draft 8) and UISP (Draft 12), with the retained wetland system and the golf course in public open space between them (C.K. Rumboll & Vennote, 2025) (**Figure 2-1**).

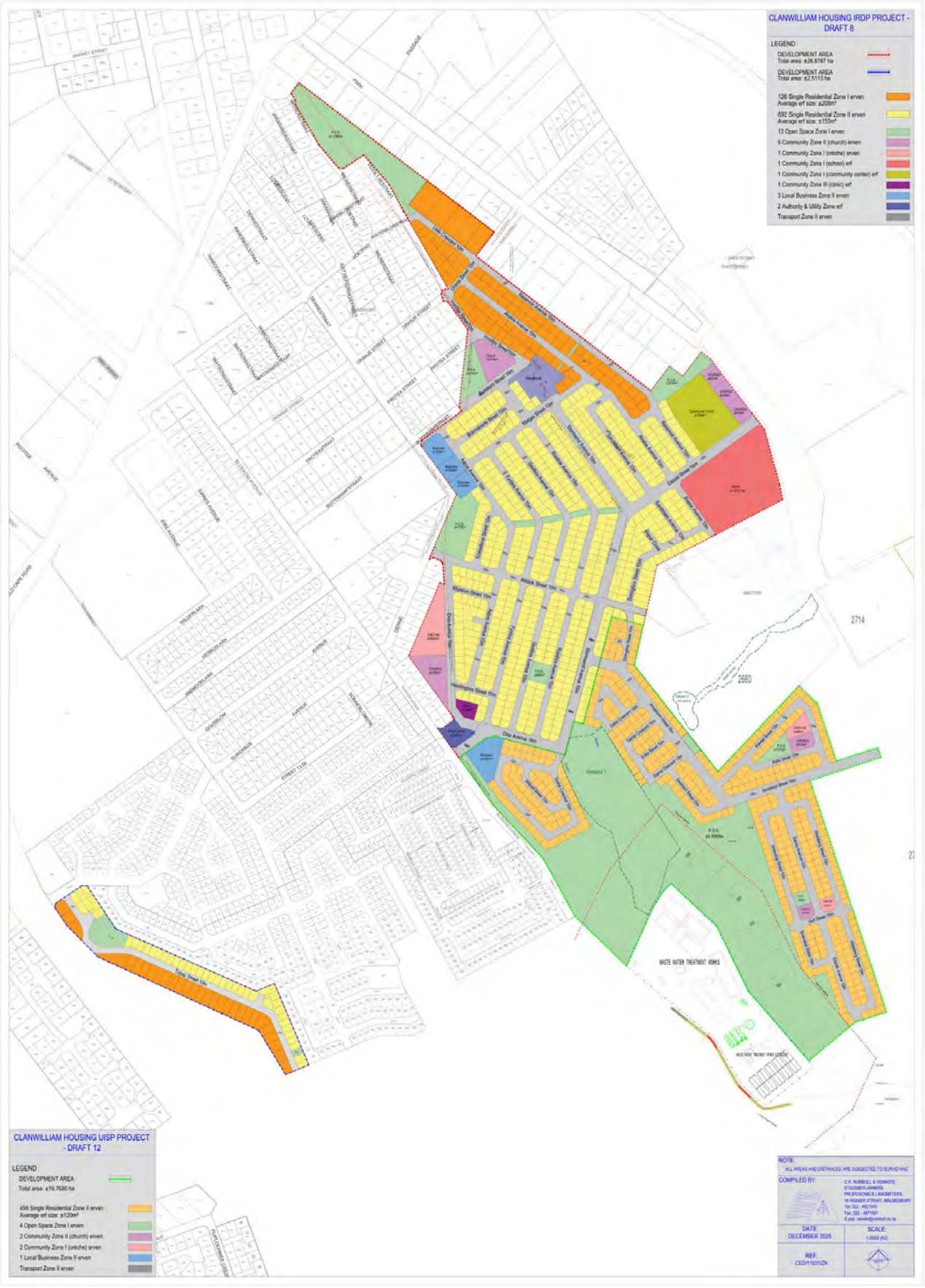


Figure 2-1: Site development plans, showing Wetland 1, the golf course and the WWTW (C.K. Rumboll & Vennote, 2025).

Stormwater will be collected by kerb inlets and underground pipes designed for the 1:5-year event, with larger events conveyed in the road reserves, and discharged through headwalls into the retained wetland system and towards the Jan Dissels River (UDS Africa, 2026b; Enviro-EAP, 2026) (**Figure 2-2**). The conceptual layout showed 10 headwalls, most discharging towards the Jan Dissels River, two directly into the wetland and two upstream of it (UDS Africa, 2026a). The tender-stage layout has 21 numbered headwalls, with design discharges of 17 to 843 l/s through 375 to 750 mm pipes, and four attenuation ponds (Ponds 1, 2, 6 and 7) (UDS Africa, 2026b). Overflow from Wetland 1 to Wetland 2 (both form part of the unchannelled valley-bottom wetland system) will be piped beneath the golf course.

The ponds were sized with the Abt and Grigg method to attenuate the 1:100-year peak inflow to the post-development 1:2-year flood peak (UDS Africa, 2026b) (**Table 2-1**). Pond 7, the largest, provides 4 853 m³ of storage against 2 913 m³ required and reduces a 1:100-year inflow of 5 863 l/s to 209 l/s. Pond 1's designed outflow (417 l/s) is marginally above its allowable rate (410 l/s). Each pond outlet is a field inlet or headwall with an open top for emergency overflow.

Table 2-1: Stormwater attenuation ponds (UDS Africa, 2026b).

Pond	1:100-year inflow (l/s)	Allowed / designed outflow (l/s)	Required / provided storage (m³)	Max. depth (m)
Pond 1	1 326	410 / 417	379 / 1 862	1.25
Pond 2	1 081	334 / 330	309 / 390	1.25
Pond 6	930	287 / 127	266 / 953	1.3
Pond 7	5 863	528 / 209	2 913 / 4 853	1.2

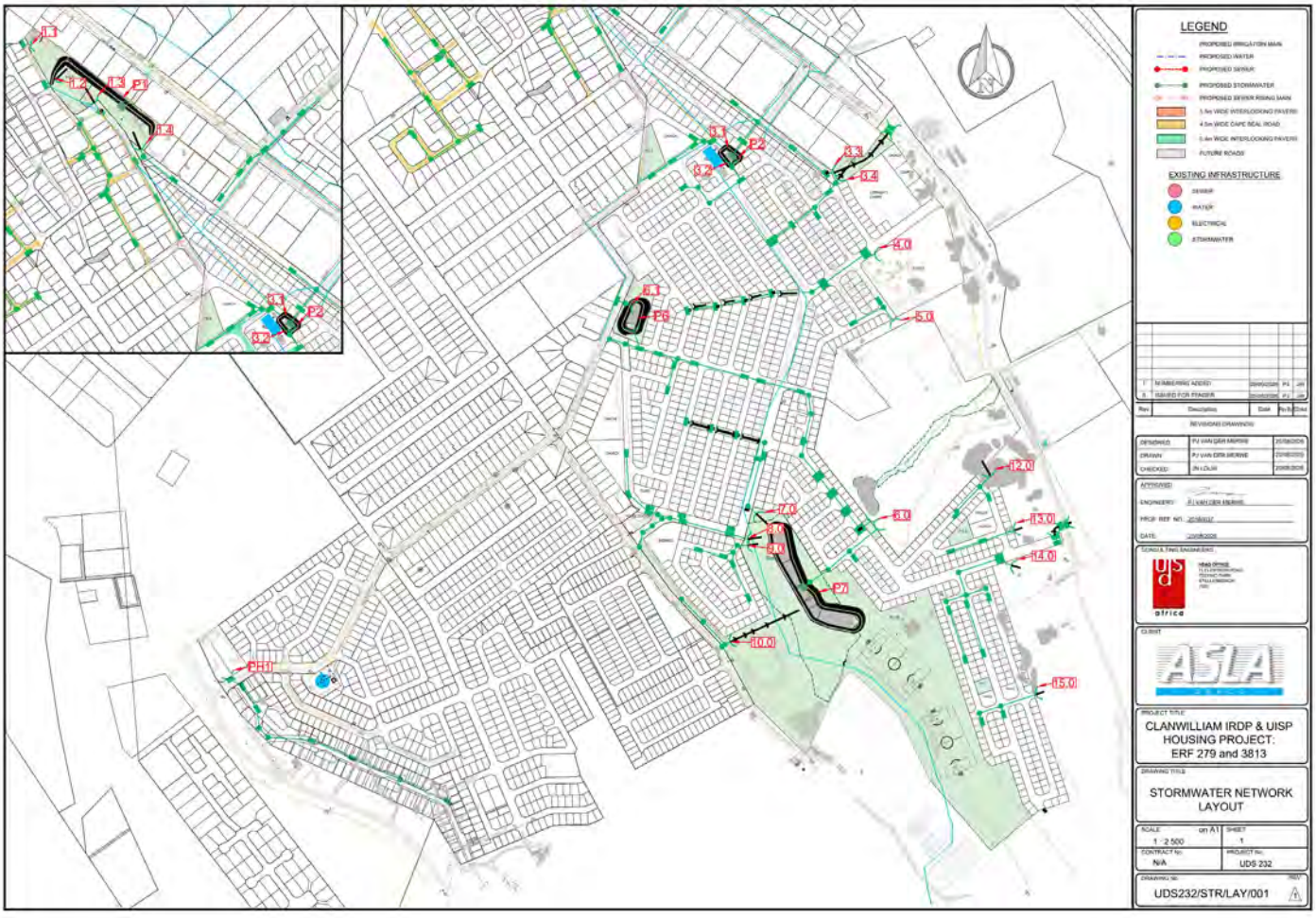


Figure 2-2: Stormwater network layout, drawing UDS232/STR/LAY/001 Rev 1 (UDS Africa, 2026b).

2.2. Clanwilliam WWTW Refurbishment and Expansion

The existing WWTW has two oxidation ditch modules with a rated capacity of 2 400 m³/day according to the municipality, and BVi (2024) reports a measured average inflow of 2 257 m³/day (94% of capacity), with an organic load well above the design load. Reported capacities of the existing works differ: 2.1 Ml/day (UDS Africa), 2.4 Ml/day (BVi, 2024) and 3 Ml/day (DWS, 2022; 2026). BVi (2024) explains that the plant can treat 2 400 m³/day only at a limited organic load (COD up to 580 mg/l), and about 2 100 m³/day at a COD of 650 mg/l, whereas the sewage received has a COD of about 978 mg/l. Its effective capacity at the actual organic load is therefore lower than its rated capacity. Effluent is chlorinated ahead of a maturation pond and discharged to the Jan Dissels River about 350 m south-east of the works, and a large portion is used to irrigate the golf course (BVi, 2024). The works does not have a valid Water Use Licence (WUL) (BVi, 2024). DWS (2026) reports that licence applications have been made for the Cederberg works other than Citrusdal, which operate under a General Authorisation (GA) in the meantime.

The effluent compliance record in BVi (2024) covers January 2020 to March 2021, before the recent refurbishment. Over these 15 months the monthly average final effluent did not meet the General Limit Values for faecal coliforms (2 419 per 100 ml in every month, probably the upper reporting limit of the test, against a limit of 1 000), COD (124 to 683 mg/l, against 75 mg/l) or ammonia (21.8 to 71.0 mg/l as N, against 6 mg/l) in any month, or for suspended solids in 14 of the 15 months (up to 333 mg/l, against 25 mg/l). Orthophosphate exceeded 10 mg/l as P in two months, while pH, electrical conductivity, nitrate and nitrite complied throughout. Overall compliance was 54% (BVi, 2024).

The DWS Green Drop assessments show the same pattern over a longer period. The works scored 3% in 2009, 63% in 2011, 52% in 2013, 51% in the 2021 audit and 23.4% in the 2023/24 audit (DWA, 2011; DWS, 2022; 2026). In 2011 its wastewater quality compliance was scored at 20%, and DWA noted excessive scum and algal growth and the poor condition of the disinfection contact channels (DWA, 2011). In the 2021 audit, effluent and sludge compliance was scored at 12% and there were too few results to calculate compliance by category. DWS recorded that about 80% of the effluent was used for irrigation and 20% was discharged to the Jan Dissels River, and found that the inlet flow meter and the chlorine gas system were not working, that disinfection relied on floating chlorine tablets and that the maturation pond was short-circuiting (DWS, 2022). In 2023, microbiological compliance was 37.5%, chemical compliance 52.2% and physical compliance 68.2%, and DWS noted Clanwilliam as the Cederberg works with poor effluent compliance (DWS, 2023b). In the 2023/24 audit, microbiological compliance was 0%, chemical compliance 33% and physical compliance 67%, and effluent and sludge compliance was scored at 8.6% (DWS, 2026). *The works has been rated high risk in each assessment since 2022, with a Cumulative Risk Rating of 82.4% (2022), 88.2% (2023) and 76.5% (2024) of the maximum (DWS, 2026).*

During the DWS site inspection for the 2025 report, the new aeration basin and clarifier appeared not to be working while the older module was. A wall of the chlorine contact channel had collapsed, so that final effluent bypassed disinfection, and final effluent was overflowing from the sump because the golf course was not pumping enough for irrigation. This means that inadequately disinfected treated wastewater was overflowing from the system and potentially entering the surrounding environment because of both a structural failure and insufficient irrigation demand/pumping capacity. None of the municipality's flow meters were working during the audit year, so no flow figures were available (DWS, 2026). The refurbishment of the existing works has since been completed (C. Louw, UDS Africa, pers. comm., 25 September 2026), and some of the defects found by DWS may have been addressed. No effluent results since the refurbishment were available for this assessment.

The upgrade comprises refurbishment of the existing equipment, a lined night storage pond, a new 1.5 Ml/day activated sludge reactor and clarifier, and a new chlorine contact tank, giving a new rated

treatment capacity of 3 600 m³/day, with the works intended to treat at least 3 600 m³/day on a constant basis during peak conditions. The night storage pond (about 1 500 m³) holds peak flows for treatment during off-peak periods; BVi (2024) refers to it as a 500 m³/day short-term increase in capacity, but it does not add treatment capacity. *It is designed to meet the Special Limit Values, including COD below 30 mg/l, ammonia below 2 mg/l and phosphate below 1 mg/l (BVi, 2024).*

UDS Africa (C. Louw, pers. comm., 25 September 2026) confirmed that the existing works has a capacity of 2.1 Ml/day and that the new 1.5 Ml/day module will bring it to 3.6 Ml/day. The module is sized for about 15 years of growth of the town, not only for the 1 277 new erven. The existing plant has been refurbished over the past 15 months, after the period of non-compliance reported by BVi (2024). The night storage pond is for hydraulic peaks and has been used once, when the inlet screen failed.

There is no direct discharge point on the river. Treated effluent is piped underground and released just below the golf course into a Common Reed (*Phragmites australis*)bed, through which it drains to the Jan Dissels River. Effluent is drawn off for golf course irrigation all year, and a flow meter has recently been installed on the draw-off (C. Louw, pers. comm., 25 September 2026). The town's potable water is abstracted from the Jan Dissels River upstream of the effluent release. A water balance for the upgraded works was not available at the time of writing.

3. Methodology

The methodology used in this addendum is described in **Annexure B** and summarised here:

- a desktop review of the earlier aquatic assessments (Enviro-EAP, 2026; EnviroSwift, 2025) and of the national and provincial spatial datasets (NWM5, NFEPA, NBA 2025 and WCBSP 2023);
- a site assessment on 29 September 2026, confirming the delineation and classification of the watercourses (DWAF, 2008; Ollis *et al.*, 2013) at the proposed stormwater outlets and the WWTW outfall;
- assessment of the Present Ecological State (PES) of Wetlands 1 and 2 (associated with the unchannelled valley-bottom wetland) with WET-Health Version 2 (Macfarlane et al., 2020), and of the habitat integrity of the Jan Dissels River with the Index of Habitat Integrity (Kleynhans, 1996);
- assessment of ecosystem services with WET-EcoServices Version 2 (Kotze et al., 2020), and of Ecological Importance and Sensitivity (EIS) (DWAF, 1999; Rountree et al., 2013);
- water quality sampling of the Jan Dissels River upstream and downstream of the WWTW effluent release, analysed by NviroTek Wynland Laboratories; and
- impact assessment using the Delta Ecology impact assessment methodology, and risk assessment using the RAM of GN 4167 of 2023 (**Annexures A and B**).

4. Receiving Environment

4.1. Watercourses

4.1.1. Desktop Assessment

The receiving watercourses are the valley-bottom wetland system within the study area (Wetlands 1 and 2), the southern historical non-perennial drainage line which now consists of a reed-dominated seep wetland, and the Jan Dissels River. The Jan Dissels River flows into the Olifants River about 2.8 km downstream of the northern end of the study area and about 4.7 km downstream of the WWTW effluent

release, measured along the river. A precautionary approach has therefore been adopted and the Olifants River has also been included in the assessment.

Wetlands 1 and 2, as referred to in previous assessments, form part of the same central valley-bottom wetland system and are therefore collectively referred to as the central valley-bottom wetland system in this addendum.

EnviroSwift (2025) classified the on-site wetland system as a natural unchannelled valley-bottom wetland, hydrologically connected to the Jan Dissels River and its associated floodplain wetland. Historical mapping (see Section 4.1.2) indicates that the valley-bottom wetland occurs along a former non-perennial drainage system. The present wetland has developed along this historic drainage pathway and has been influenced by excavation, stormwater inputs from the town and the obstruction of drainage by the golf course (Enviro-EAP, 2026). For the purposes of this addendum, this feature is therefore treated as a valley-bottom wetland associated with a historic non-perennial drainage line.

A separate historic non-perennial drainage line also occurs to the south of the study area and now consist of treated effluent seepage dominated by Common Reed (*Phragmites australis*). For the purposes of this addendum, this feature is therefore referred to as the southern seep wetland.

The site lies in quaternary catchment E10H of the Olifants River system (**Figure 4-1**). The National Geographical Information Service (NGI) river dataset indicates the historic non-perennial drainage lines within and to the south of the study area, while the Jan Dissels River occurs to the east (NGI, 2019). The Jan Dissels River is a perennial river that flows through the Boskloof Valley before joining the Olifants River below Clanwilliam Dam, about 2.8 km downstream of the northern end of the study area and about 4.7 km downstream of the WWTW effluent release, measured along the river (OpenStreetMap contributors, 2026). The Jan Dissels River is classified as PES Category D (Largely Modified) (Van Deventer et al., 2019), with a Very High Ecological Importance (EI) and Very High Ecological Sensitivity (ES) (DWS, 2014). The Olifants River downstream of its confluence with the Jan Dissels River is similarly classified as PES Category D, with a Moderate EI, and a Very High ES.

The NFEPA (CSIR, 2011) spatial dataset for wetland vegetation types, where present, indicates that the study area corresponds with the Northwest Sand Fynbos, which is listed as Critically Endangered (CR) with protection level of Zero Protection (ZP).

The Jan Dissels River corridor is mapped as a CBA 1 and much of the site as an ESA 1 in the Western Cape Biodiversity Spatial Plan (CapeNature, 2023) (**Figure 4-2**). The site does not fall within a Strategic Water Source Area.

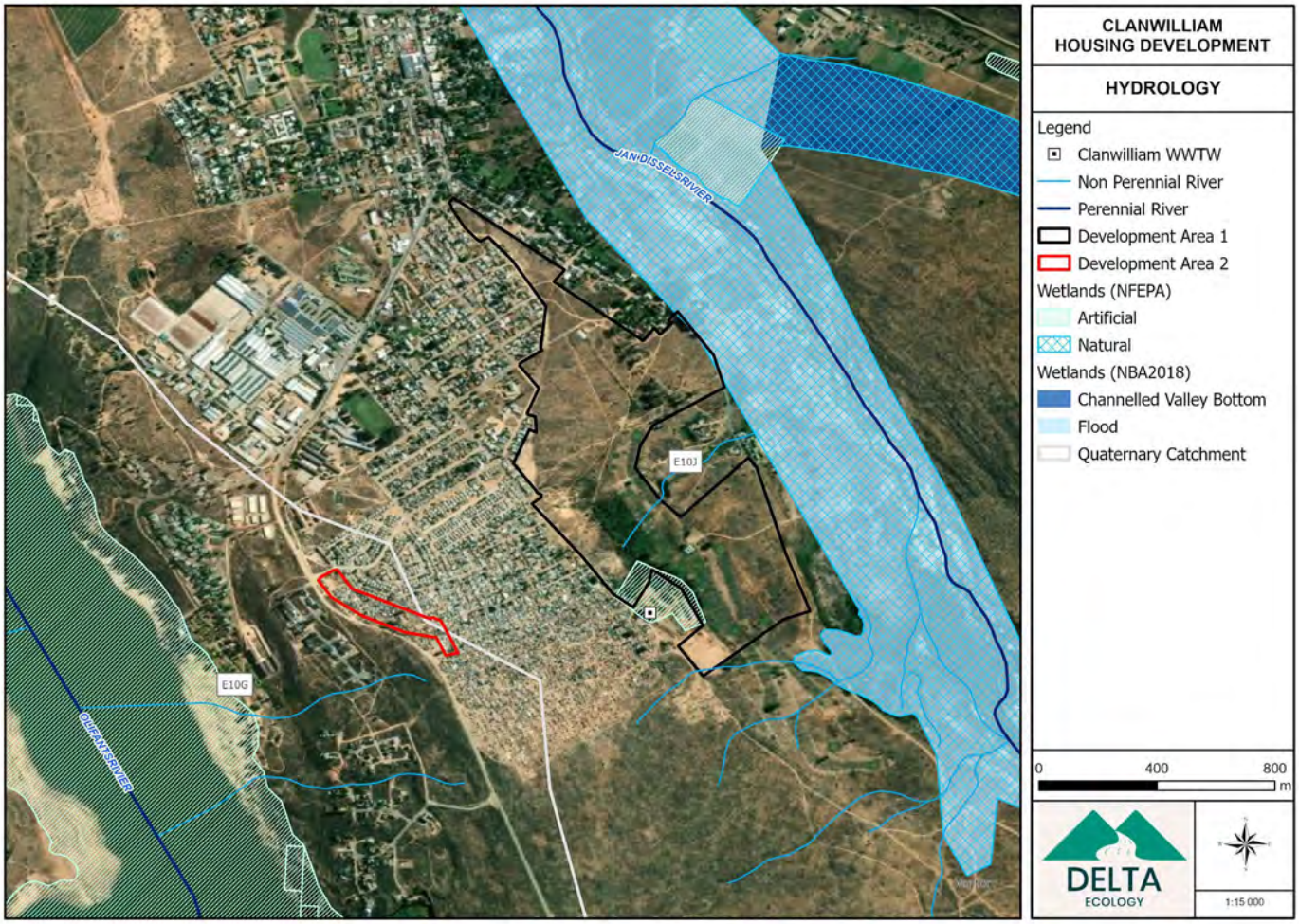


Figure 4-1: Mapped rivers and wetlands in the vicinity of the site.

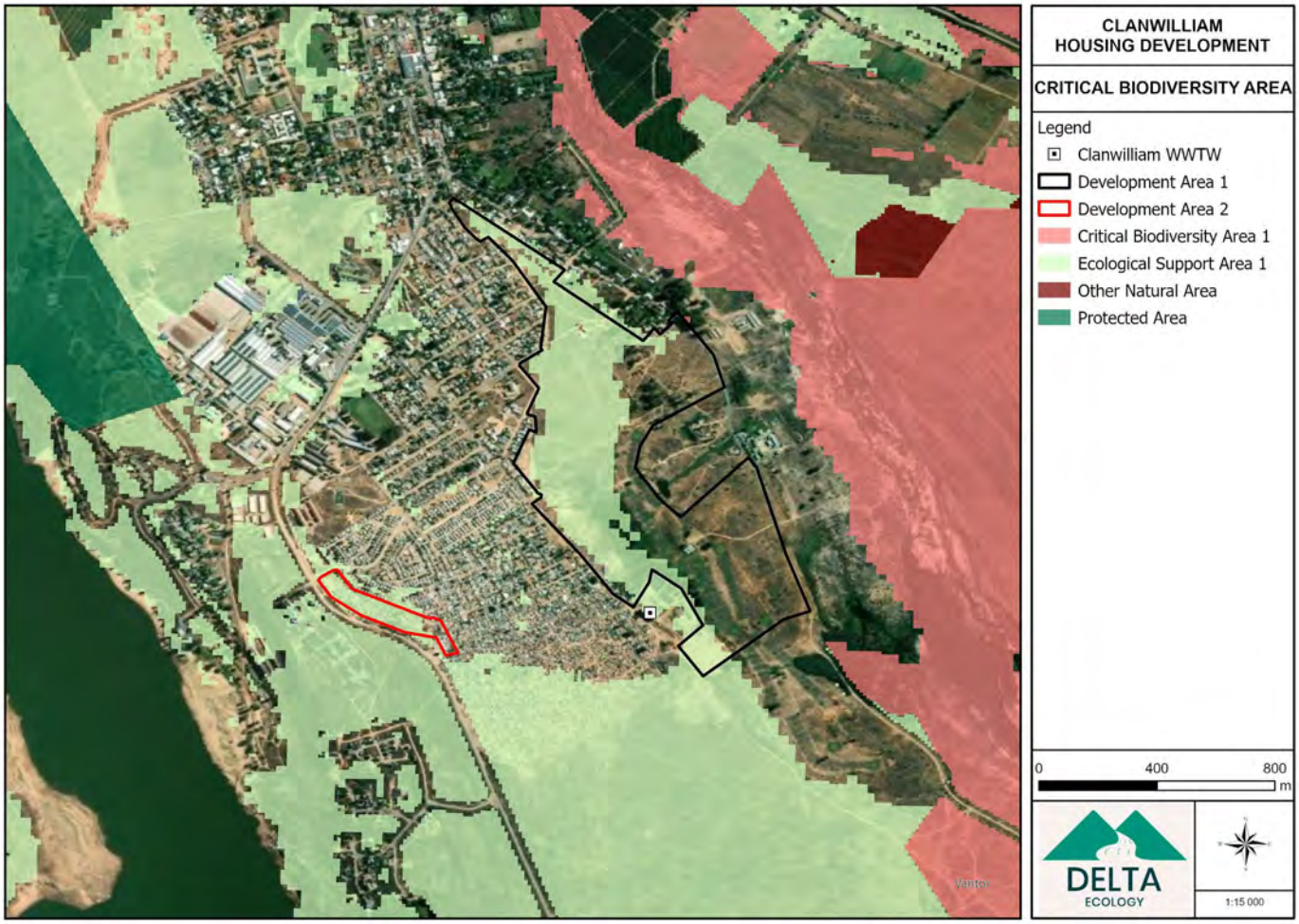


Figure 4-2: Western Cape Biodiversity Spatial Plan categories (CapeNature, 2023).

The terrestrial vegetation type is Citrusdal Vygieveld (**Figure 4-3**), listed as Least Concern (NBA 2021) and as Vulnerable in the NFEPA threatened ecosystems layer. The underlying geology is arenite, and the land types are Fc794, Fc795 and Ia196 (**Figure 4-4**).

The terrestrial assessment found the Citrusdal Vygieveld on the eastern part of the site to be in moderate condition: succulent-rich shrubland of vygies on sandy and rocky soils, with annuals in the open spaces. The remaining habitats are the degraded wetlands (alien invasive plants, waste and rubble), the golf course and areas cleared by informal settlement and infrastructure (Hanekom, 2026a). Recorded species include *Albuca maxima, Babiana ecklonii, Brunsvigia bosmaniae, Conicosia pugioniformis, Galenia africana, Roepera morgsana* and *Trachyandra muricata*, and no threatened or protected plant species were recorded (Hanekom, 2026b). Overall terrestrial sensitivity was rated low (Hanekom, 2026a).

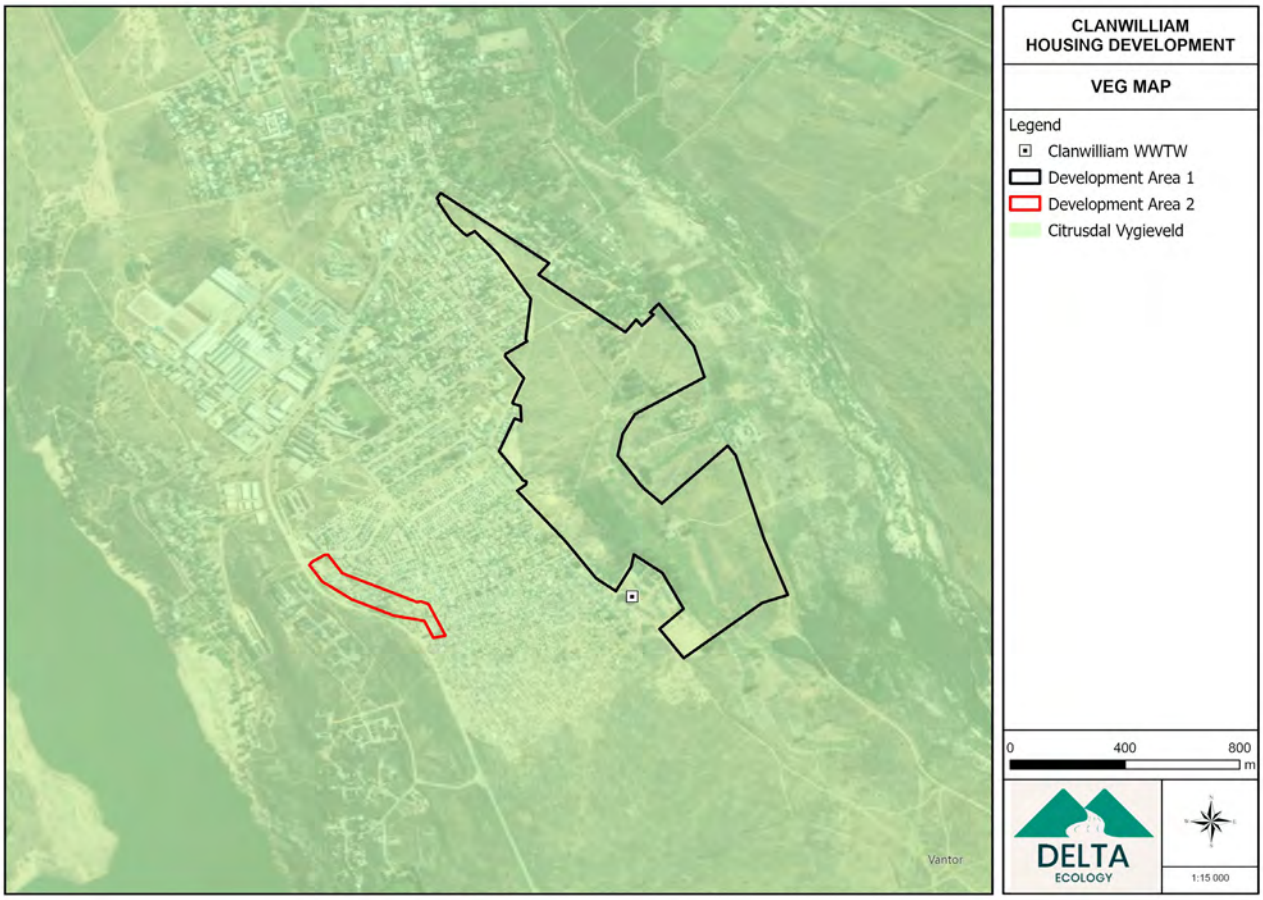


Figure 4-3: Vegetation types (SANBI, 2018).

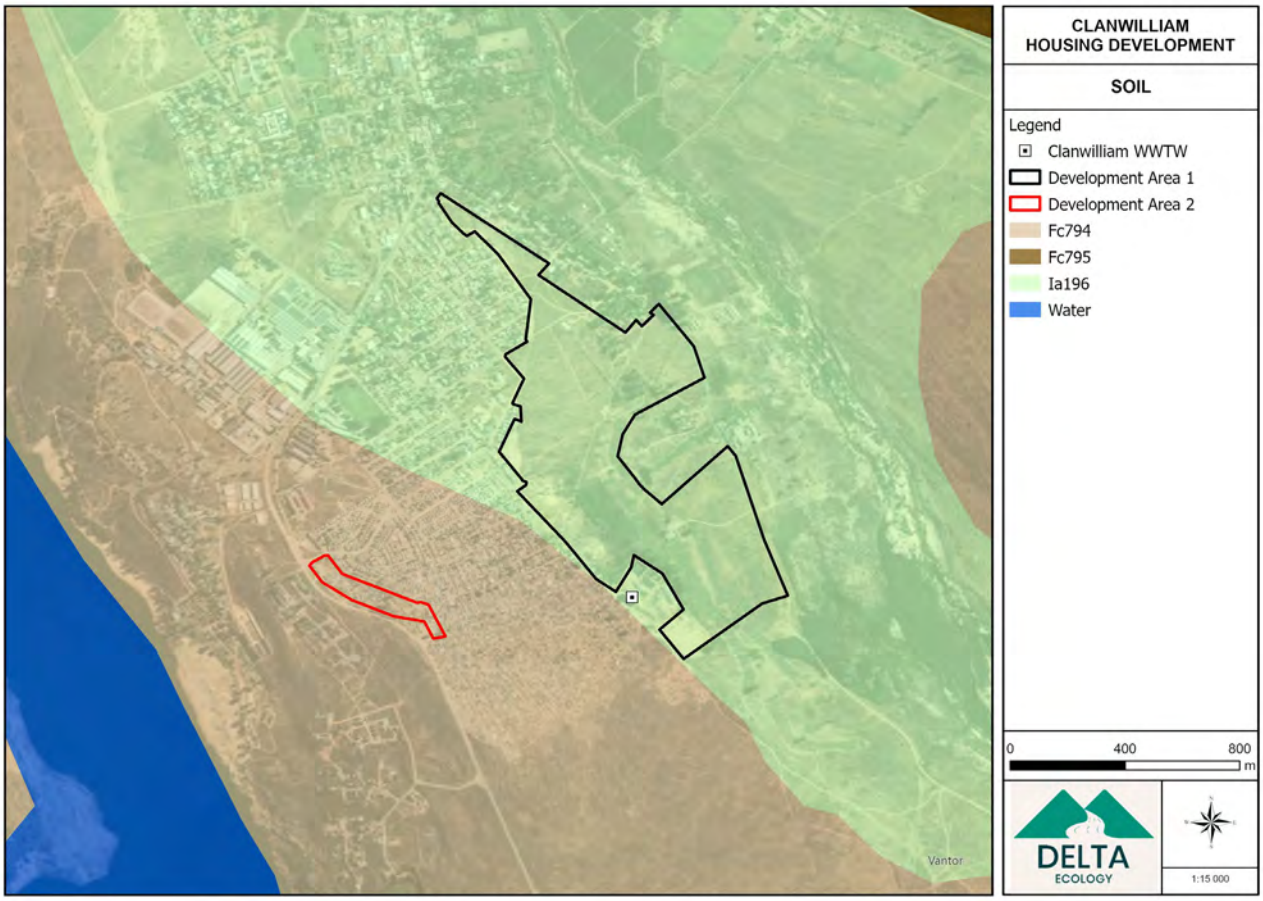


Figure 4-4: Land types.

4.1.2. Historical imagery

The earliest available aerial photograph, from 1948, was examined to assess the historical condition of the site (**Figure 4-6**). Extensive agriculture was already present by 1948, including clearing of natural vegetation, instream dams, tilling and reshaping of land, subdivision and fencing, and roads, and these activities extended into the floodplain of the Jan Dissels River.

Although the landscape was already transformed by 1948, the central and southern watercourses are visible as a combination of diffuse seepage and more defined channelised flow draining eastwards towards the Jan Dissels River. The watercourses appear to have been confined along their western side by a linear feature, possibly a road or historical leiwater furrow. Similar drainage features occur elsewhere west of the Jan Dissels River, suggesting that the underlying drainage systems are natural.

The source of the apparent seepage cannot be confirmed from the historical imagery. It may represent natural groundwater-fed seepage, including possible spring activity, although some influence from the historical furrow system that supplied Clanwilliam with water from the Jan Dissels River is also possible. In their natural reference state, these systems are therefore likely to have comprised a combination of seepage wetland habitat and a valley-bottom wetland and/or drainage line system.

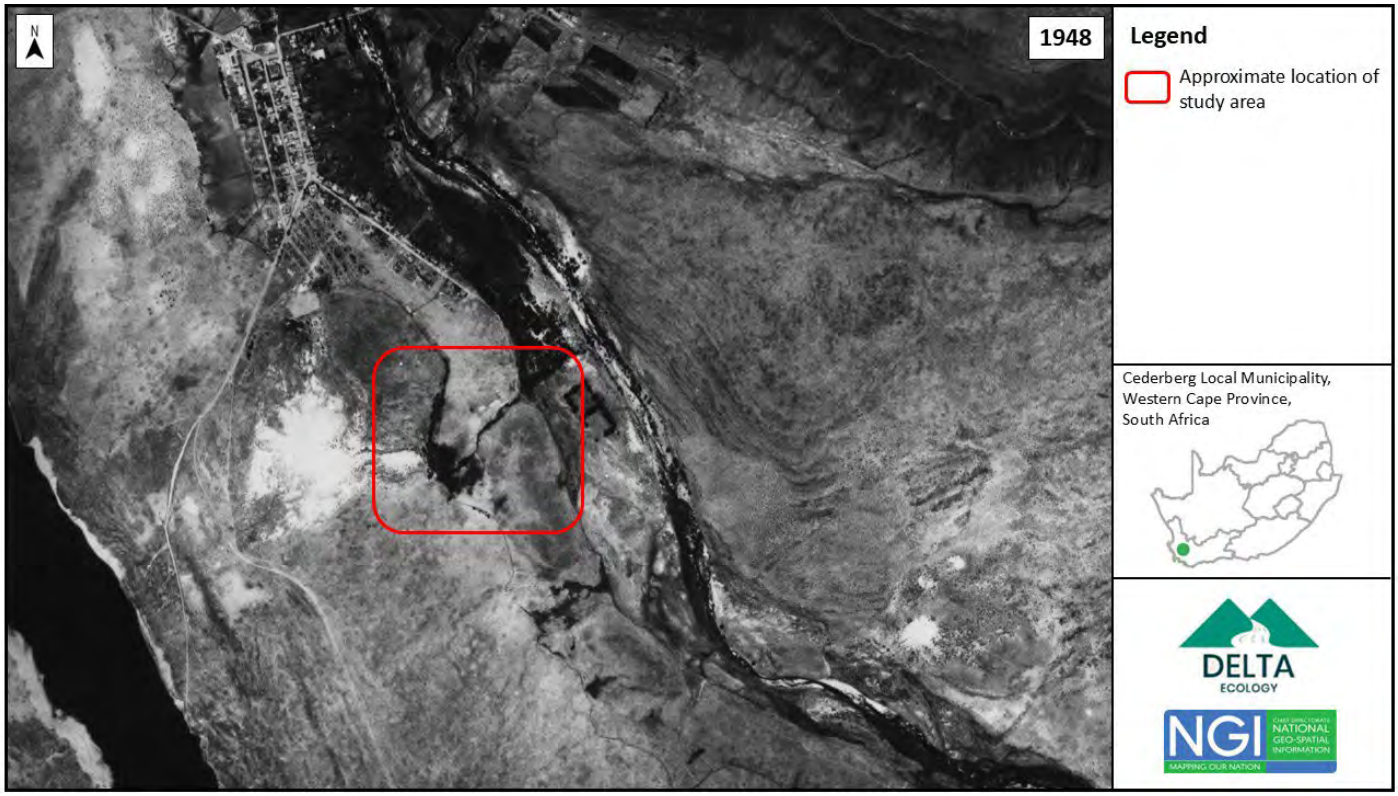


Figure 4-5: 1948 aerial photograph of the site, showing the two tributary channels, seepage, and agricultural disturbance (NGI, 1948).

4.1.3. Site assessment

The site was visited on 29 September 2026, at the end of the wet season, by Kimberley van Zyl of Delta Ecology together with Fergus Swartz of UDS Africa.

The central watercourse system is seriously modified, and currently receives stormwater from the informal settlement and township upslope and is likely to be polluted. Its upstream extent is dominated by *Phragmites australis* and *Typha capensis*, with arum lilies (*Zantedeschia aethiopica*), Port Jackson (*Acacia saligna*) and dumped tyres (**Figure 4-7**). A golf course has been constructed through approximately 120 m of the watercourse. Flow is maintained by means of a stormwater pipe beneath the golf course, to an artificially excavated depression dominated by *Typha capensis.* The watercourse then flows through a channel dominated by Kikuyu grass, arum lilies, and ruderal weed species, until it reaches Spokie road and associated culvert, and subsequently drains into the Jan Dissels floodplain wetland (**Figure 4-8**).

The southern watercourse system has similarly been seriously to critically modified. The historic channel form is no longer clearly evident, and the system now consists of a large seep dominated by dense *Phragmites australis* and *Typha capensis*, sustained by treated effluent discharge from the WWTW. Treated effluent leaves the works in an underground pipe and is released just below the golf course (**Figure 4-9**). It pools in places and then flows through the large, dense reed bed before entering the Jan Dissels River.

The at-risk stretch of the Jan Dissels River and associated floodplain is largely modified. Plant species identified include the indigenous wetland and riparian species palmiet (*Prionium serratum*), giant sedge (*Cyperus thunbergii*), Stembract clubrush (*Ficinia nodosa*), leafy rush (*Juncus lomatophyllus*) and Cape willow (*Salix mucronata*), and kraalbush (*Aizoon africanum*) (associated with disturbed vegetation) on drier ground. Two NEM:BA Category 1b invasive species were recorded: Port Jackson (*Acacia saligna*) and scarlet sesbane (*Sesbania punicea*).

The Jan Dissels River has been modified by the abstraction of potable water for Clanwilliam just upstream of the study area, effluent discharge from the WWTW, and numerous stormwater outlets associated with the town. Further modification is associated with agricultural development, including abstraction and the construction of berms within the river corridor, as well as the historical expansion of Clanwilliam into portions of the river's floodplain.

The Olifants River and its associated floodplain are largely modified in the vicinity of the Jan Dissels River confluence. Clanwilliam Dam, located upstream, has substantially altered the natural flow regime by regulating winter flows and releasing water during summer to meet downstream irrigation demands (DWAF, 2006; Brown et al., 2010). These changes have affected the natural seasonal flow patterns and associated aquatic habitats. Agricultural development has also encroached into the historical floodplain, resulting in the loss and modification of natural riparian vegetation and disturbance of the riverbanks. Agricultural berms and other infrastructure within the floodplain have further modified the natural floodplain characteristics.

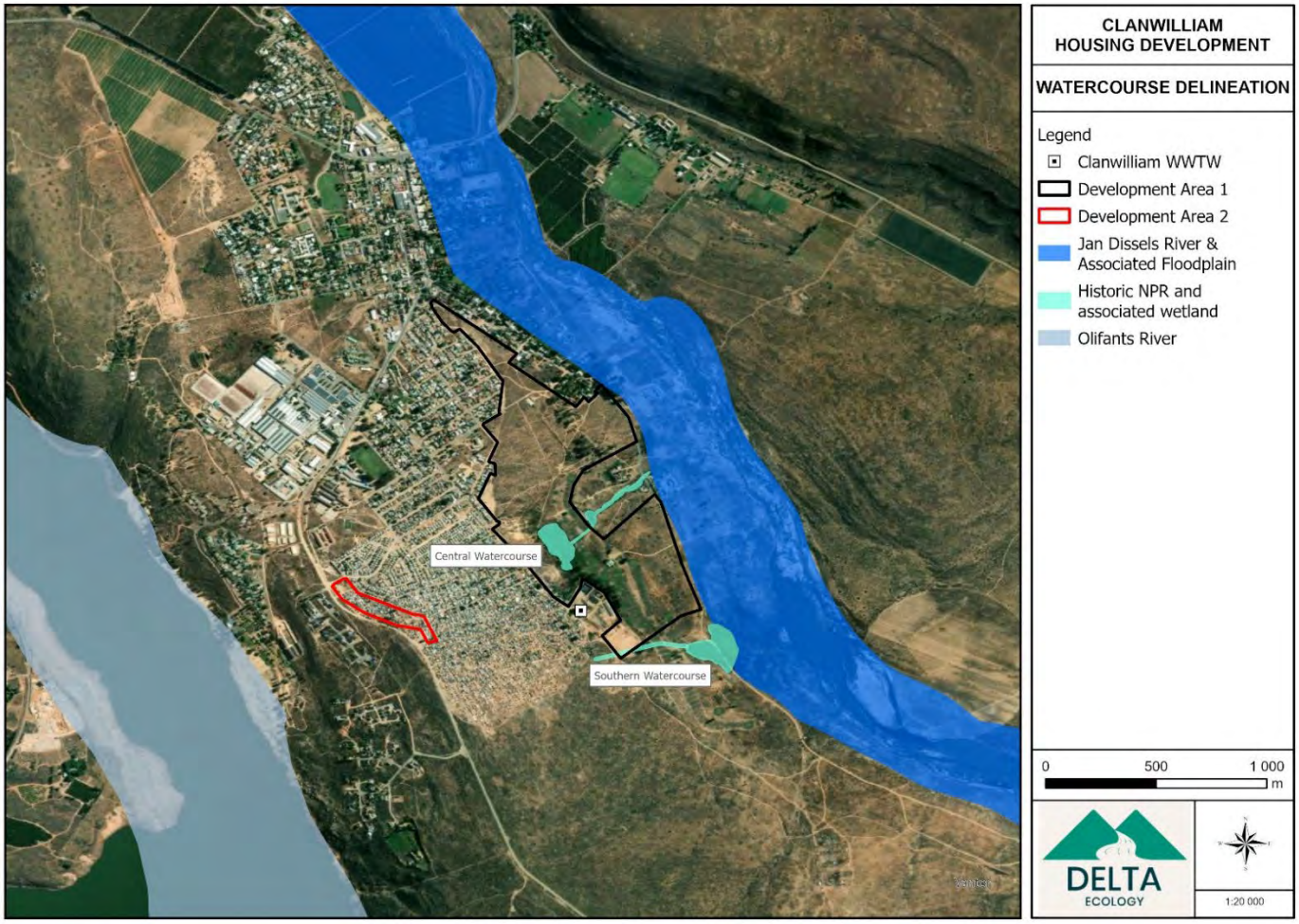


Figure 4-6: Delineated watercourses in the vicinity of the site.

Figure 4-7: (a) Central watercourse with *Typha capensis, Acacia saligna* and dumped tyres; (b, c) discharge through a piped culvert system beneath the golf course to the artificial depression dominated by *Typha capensis* (29 September 2026).

Figure 4-8: (a) Central watercourse downstream of the site resembling a valley bottom system dominated by Kikuyu and ruderal weed species, (b) Culvert under Spokie Street at the downstream end of the wetland; (c) drainage channel to the Jan Dissels River (29 September 2026).

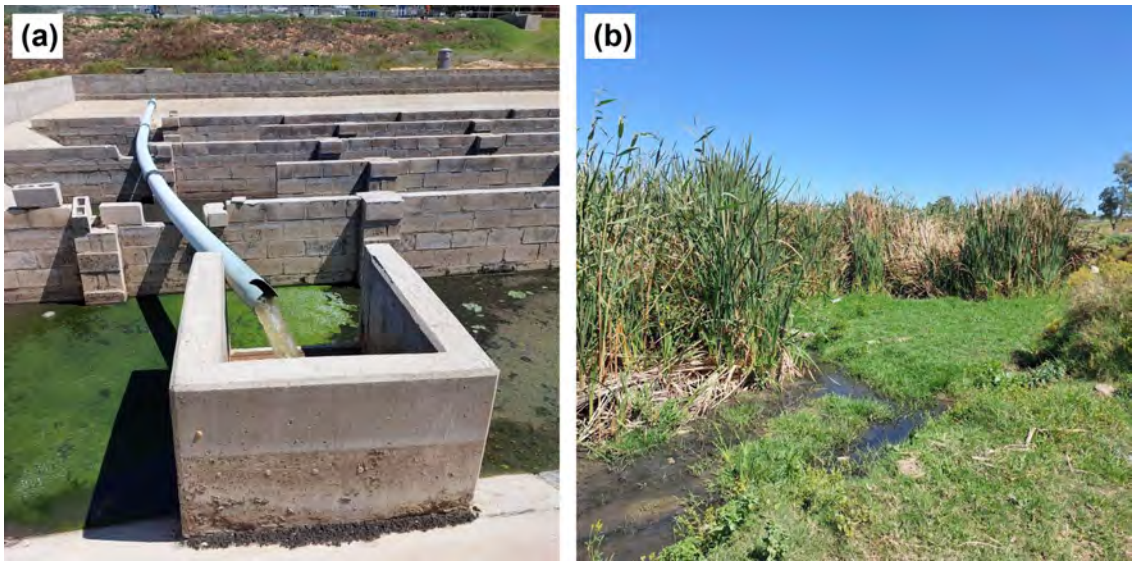


Figure 4-9: (a) Treated effluent outlet at existing WWTW; (b) *Phragmites australis* and *Typha capensis* reed bed receiving the effluent, after which it flows into the Jan Dissels River.

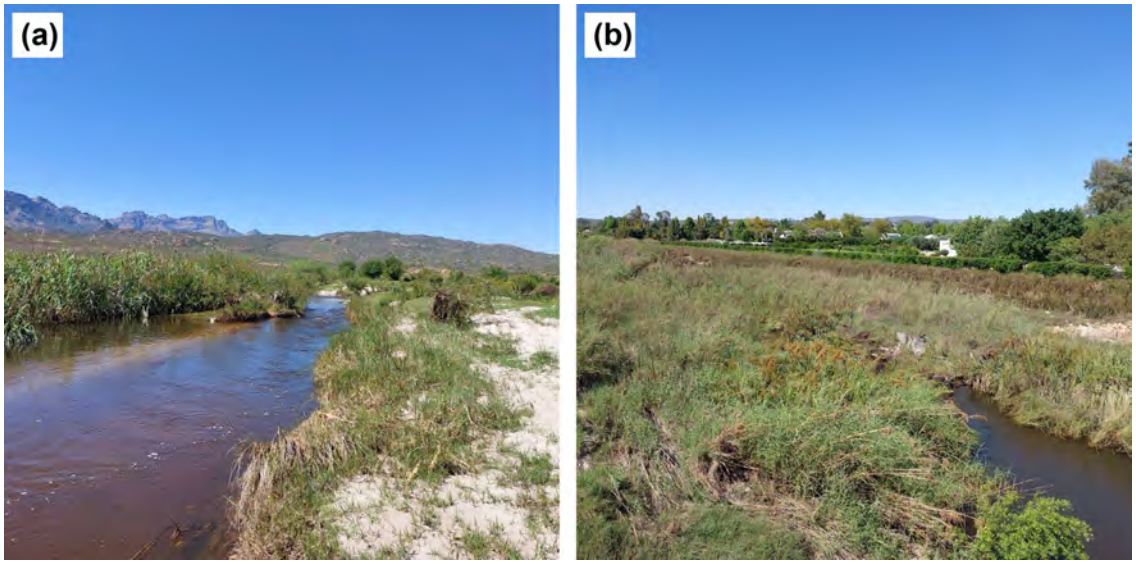


Figure 4-10: (a) Jan Dissels River at the upstream sampling point; (b) Jan Dissels River downstream, where it flows through Clanwilliam town and farmland.

4.2. Wetland Present Ecological State

The mapped central non-perennial river identified by NGI (2019) was determined to represent a central valley-bottom wetland system. Historically, the Clanwilliam Golf Course has impacted the wetland, while stormwater runoff from the upslope urban area has also contributed to impacts on the wetland. The downslope extent of the wetland has been modified by excavation to create a small dam/pond. After which flow drains through a channel, under Spokie Road in a culvert. The wetlands hydrology, water quality, vegetation, and geomorphology has been largely to seriously degraded.

Despite these disturbances, areas of natural wetland habitat and associated aquatic biota remain. Natural habitat is particularly evident within the two areas (referred to in previous reports as Wetland 1 and 2) supporting wetland obligate vegetation, although these areas have been partially impacted by alien invasive vegetation. The wetland is characterised by wetland obligate vegetation, including *Typha capensis* (bullrush) and *Phragmites australis* (common reed), which indicate persistent wetland conditions.

The final WET-Health score for the central valley-bottom wetland system is 39.9%, a PES of E (Seriously Modified), with hydrology, water quality and vegetation seriously modified (E) and geomorphology largely modified (D) (**Table 4-1**). An E category lies between the PES F given by Enviro-EAP (2025) and the PES D given by Enviro-EAP (2026), and supports EnviroSwift's (2025) view that the wetland is not completely transformed.

The Jan Dissels River floodplain wetland (about 349 ha), the Olifants River floodplain wetland (about 635 ha) and the southern seep (about 2.3 ha), identified in the delineation (**Figure 4-5**), were also assessed with WET-Health Version 2 (**Table 4-1**). The scores reported are the final scores, in which selected modelled impact scores were refined on the basis of the site assessment.

The Jan Dissels floodplain is largely modified (PES D, 46.7%). Its hydrology is seriously modified (E), reflecting changes to flood peaks and the seasonality of flows and the treated effluent it receives, and downstream of the town's potable water abstraction point the floodplain has dried out. Its water quality and vegetation are largely modified (D) and its geomorphology moderately modified (C). The Olifants floodplain is largely modified (PES D, 40.1%, close to the boundary with category E), with hydrology and geomorphology seriously modified (E), mainly because of flow regulation by Clanwilliam Dam, and water quality and vegetation largely modified (D).

The southern seep is seriously modified (PES E, 25.7%). Its hydrology and water quality are critically modified (F) because it is sustained by treated effluent from the WWTW, its vegetation is seriously modified (E) and its geomorphology largely modified (D). These results are in line with the PES D of the Jan Dissels and Olifants River in the NBA 2018 (Van Deventer et al., 2019).

Table 4-1: WET-Health Version 2 results (final, adjusted scores).

	Hydrology	Geomorphology	Water quality	Vegetation	Overall PES
Central valley bottom system	39.7% (E)	49.2% (D)	38.7% (E)	32.4% (E)	E (39.9%)
Jan Dissels River floodplain wetland	34.8% (E)	75.0% (C)	43.2% (D)	57.5% (D)	D (46.7%)
Olifants River floodplain wetland	39.9% (E)	29.3% (E)	51.6% (D)	40.0% (D)	D (40.1%)
Southern Seep	18.2% (F)	52.2% (D)	17.4% (F)	30.0% (E)	E (25.7%)

4.3. River Habitat Integrity

The assessment results for the instream and riparian habitat of the delineated Jan Dissels and Olifants River are presented in **Table 4-2**. The assessment resulted in an Instream and Riparian Habitat Integrity score of PES Category of D (Largely Modified) for both rivers.

Both rivers are subject to several anthropogenic impacts, including water abstraction for agriculture and potable water, residential and industrial runoff from upslope Clanwilliam, and runoff from surrounding agricultural areas. The discharge of treated effluent from the WWTW is a notable influence on the Jan Dissels River and can affect both water quality and the flow regime. Riparian vegetation comprises a mixture of indigenous and alien species, indicating some disturbance to the riparian habitat. The Olifants River has also been transformed by the Clanwilliam Dam upstream of the confluence of the Jan Dissels River.

The two historic non-perennial tributaries of the Jan Dissels River are both seriously to critically modified, with an instream habitat integrity of 21% (E/F) and a riparian habitat integrity of 5% (F) (**Table 4-2**).

Table 4-2: IHI results for the Jan Dissels & Olifants River reaches.

	Instream IHI (%)	Instream category	Riparian IHI (%)	Riparian category
Jan Dissels River	58	D	44	D
Olifants River	42	D	41	D
Historic non-perennial tributaries of the Jan Dissels River	21	E/F	5	F

4.4. Ecosystem Services

The watercourses were assessed for their contribution to ecosystem services using the WET-EcoServices Version 2 methodology, which covers sixteen potential ecosystem services, including both direct and indirect benefits to people. The results for the central valley-bottom wetland system, the southern seep and the Jan Dissels and Olifants River floodplain wetlands are given in **Table 4-3** to **Table 4-6**.

The central valley-bottom wetland system received predominantly low to very low scores, indicating a limited contribution to ecosystem services. Its highest scores, moderately low, were for sediment trapping, nitrate assimilation and toxicant assimilation, reflecting the demand created by the polluted stormwater it receives from the town (**Table 4-3**). The southern seep scored moderate for sediment trapping and for phosphate, nitrate and toxicant assimilation, reflecting its role in polishing the treated effluent from the WWTW before it reaches the Jan Dissels River, and low to very low for its other services (**Table 4-4**).

The Jan Dissels River floodplain wetland makes a substantial contribution to ecosystem services (**Table 4-5**). It scored very high for biodiversity maintenance, reflecting its position within the Aquatic CBA corridor and the Critically Endangered wetland vegetation type, and for water for human use, reflecting abstraction from the river for the town and for agriculture. It also scored very high for sediment trapping and for nitrate and toxicant assimilation, reflecting the high demand for these services from the treated effluent and the urban and agricultural runoff it receives, and moderately high for flood attenuation, phosphate assimilation and cultivated foods.

The Olifants River floodplain wetland scored very high for biodiversity maintenance, sediment trapping and water for human use, the last reflecting the demand for water from the river below Clanwilliam Dam, high for toxicant assimilation, and moderately high for nitrate assimilation, carbon storage and cultivated foods (**Table 4-6)**. Its other services were moderate to very low.

Table 4-3: Ecosystem services assessment results for central valley bottom system.

		Present State			
ECOSYSTEM SERVICE		Supply	Demand	Importance Score	Importance
REGULATING AND SUPPORTING SERVICES	Flood attenuation	1.4	0.7	0.2	Very Low
	Stream flow regulation	2.0	0.0	0.5	Very Low
	Sediment trapping	1.7	3.0	1.7	Moderately Low
	Erosion control	1.5	0.3	0.2	Very Low
	Phosphate assimilation	1.1	3.0	1.1	Low
	Nitrate assimilation	1.6	3.0	1.6	Moderately Low
	Toxicant assimilation	1.7	3.0	1.7	Moderately Low
	Carbon storage	1.3	2.7	1.1	Low
	Biodiversity maintenance	0.3	3.0	0.3	Very Low
PROVISIONING SERVICES	Water for human use	1.6	0.0	0.1	Very Low
	Harvestable resources	2.0	0.0	0.5	Very Low
	Food for livestock	1.5	0.0	0.0	Very Low
	Cultivated foods	2.1	0.0	0.6	Very Low
CULTURAL SERVICES	Tourism and Recreation	0.4	0.7	0.0	Very Low
	Education and Research	0.4	0.0	0.0	Very Low
	Cultural and Spiritual	1.0	0.0	0.0	Very Low

Table 4-4: Ecosystem services assessment results for southern seep.

		Present State			
ECOSYSTEM SERVICE		Supply	Demand	Importance Score	Importance
REGULATING AND SUPPORTING SERVICES	Flood attenuation	0.9	0.4	0.0	Very Low
	Stream flow regulation	2.3	0.0	0.8	Low
	Sediment trapping	2.3	2.0	1.8	Moderate
	Erosion control	1.4	0.2	0.0	Very Low
	Phosphate assimilation	1.5	4.0	2.0	Moderate
	Nitrate assimilation	2.3	3.0	2.3	Moderate
	Toxicant assimilation	2.3	3.0	2.3	Moderate
	Carbon storage	1.1	2.7	0.9	Low
	Biodiversity maintenance	0.3	3.0	0.3	Very Low
PROVISIONING SERVICES	Water for human use	2.0	0.0	0.5	Very Low
	Harvestable resources	2.0	0.0	0.5	Very Low
	Food for livestock	1.0	0.0	0.0	Very Low
	Cultivated foods	1.8	0.0	0.3	Very Low
CULTURAL SERVICES	Tourism and Recreation	0.8	0.7	0.0	Very Low
	Education and Research	0.4	0.0	0.0	Very Low
	Cultural and Spiritual	1.0	0.0	0.0	Very Low

Table 4-5: Ecosystem services assessment results for the Jan Dissels River floodplain wetland.

		Present State			
ECOSYSTEM SERVICE		Supply	Demand	Importance Score	Importance
REGULATING AND SUPPORTING SERVICES	Flood attenuation	3.2	1.9	2.6	Moderately High
	Stream flow regulation	1.2	3.0	1.2	Low
	Sediment trapping	3.3	3.0	3.3	Very High
	Erosion control	1.9	3.0	1.9	Moderate
	Phosphate assimilation	2.1	4.0	2.6	Moderately High
	Nitrate assimilation	3.2	4.0	3.7	Very High
	Toxicant assimilation	3.1	4.0	3.6	Very High
	Carbon storage	2.4	2.7	2.3	Moderate
	Biodiversity maintenance	3.8	4.0	4.0	Very High
PROVISIONING SERVICES	Water for human use	4.0	4.0	4.0	Very High
	Harvestable resources	3.0	1.0	2.0	Moderate
	Food for livestock	1.5	1.0	0.5	Very Low
	Cultivated foods	2.5	3.0	2.5	Moderately High
CULTURAL SERVICES	Tourism and Recreation	1.9	0.3	0.5	Very Low
	Education and Research	1.9	0.0	0.4	Very Low
	Cultural and Spiritual	2.0	0.3	0.7	Very Low

Table 4-6: Ecosystem services assessment results for the Olifants River floodplain wetland.

		Present State			
ECOSYSTEM SERVICE		Supply	Demand	Importance Score	Importance
REGULATING AND SUPPORTING SERVICES	Flood attenuation	3.5	0.5	2.3	Moderate
	Stream flow regulation	1.2	3.0	1.2	Low
	Sediment trapping	3.5	3.0	3.5	Very High
	Erosion control	1.9	3.0	1.9	Moderate
	Phosphate assimilation	1.9	3.0	1.9	Moderate
	Nitrate assimilation	2.7	3.0	2.7	Moderately High
	Toxicant assimilation	2.9	3.0	2.9	High
	Carbon storage	2.5	2.7	2.3	Moderately High
	Biodiversity maintenance	3.9	4.0	4.0	Very High
PROVISIONING SERVICES	Water for human use	3.0	4.0	3.5	Very High
	Harvestable resources	3.0	1.3	2.2	Moderate
	Food for livestock	1.5	2.0	1.0	Low
	Cultivated foods	2.5	3.0	2.5	Moderately High
CULTURAL SERVICES	Tourism and Recreation	2.2	3.0	2.2	Moderate
	Education and Research	1.9	0.0	0.4	Very Low
	Cultural and Spiritual	2.0	0.3	0.7	Very Low

4.5. Ecological Importance and Sensitivity

The Ecological Importance and Sensitivity (EIS) of the watercourses and the resulting Recommended Ecological Category (REC) (Rountree et al., 2013) are presented in **Table 4-7**. The central valley-bottom wetland system and the southern seep are of Moderate EIS. The Jan Dissels and Olifants rivers and their floodplain wetlands are of Very High EIS, reflecting their position within the CBA 1 corridor, the Critically Endangered wetland vegetation type, their very high importance for biodiversity maintenance and water supply (**Table 4-5 and Table 4-6**) and the high sensitivity of floodplains to changes in their flood regime. This is consistent with the DWS (2014) desktop assessment, which rates the integrated EIS of both the Jan Dissels (E10H-07331) and the Olifants (E10J-07292) sub-quaternary reaches as Very High (Section 4.7).

Under the REC rules of Rountree et al. (2013), a watercourse with a PES of B to D and a High or Very High EIS should be improved by one category where practically possible, and one with a PES of E or F should be rehabilitated to at least category D. The REC of the Jan Dissels and Olifants rivers and their floodplain wetlands is therefore C. The REC of the central valley-bottom wetland system, including the historic central tributary along which it lies, is D, to be achieved by implementing the Wetland Rehabilitation and Management Plan prepared for the development (Delta Ecology, 2026) together with treatment of stormwater before it enters the wetland. Rehabilitation of the southern seep and the historic southern tributary is not considered practical, because the original drainage line has been lost through a long history of disturbance and the feature is now sustained by treated effluent from the WWTW. No REC is therefore set for it. Its present state should be maintained and it should be retained as a polishing reed bed for the treated effluent (Section 6).

Table 4-7: EIS and REC results.

	PES / IHI	Ecosystem services	EIS	REC
Central valley bottom	E	Moderately Low	Moderate	D (through the Rehabilitation Plan)
Southern Seep	E	Moderate – Moderately High	Moderate	Not set; maintain present state
Jan Dissels River & floodplain wetland	D	Very High	Very High	C
Olifants River & floodplain wetland	D	Very High	Very High	C
Historic non-perennial tributaries	E/F (instream), F (riparian)	Not assessed	Not assessed	D (central, with the central system); not practical (southern)

4.6. Water Quality

Samples were collected on 29 September 2026 from the Jan Dissels River upstream of the WWTW (JD1, -32.2028, 18.9199, just downstream of the potable water abstraction) and downstream of the effluent release (JD2, 32.1896, 18.9072), and analysed by NviroTek Wynland Laboratories (**Table 4-8**; Annexure D). The results are compared with the aquatic ecosystem guidelines (DWAF, 1996a), and E. coli, for which there is no aquatic ecosystem guideline, with the guideline for full-contact recreation (DWAF, 1996b). The wastewater limits of the General Authorisation (**Table 4-9**) apply to the final effluent rather than to the river.

Upstream of the works, the Jan Dissels River was slightly acidic and low in dissolved salts (pH 6.55, EC < 8.4 mS/m), with little ammonia (0.07 mg N/l) and no detectable phosphate. Its nitrate concentration (2.0 mg N/l), however, already placed it at the upper end of the mesotrophic range, which may reflect runoff from farmland upstream.

Downstream, the water quality had changed markedly. pH rose by 0.8 units and EC increased at least sevenfold to 59.8 mS/m, both well beyond the Target Water Quality Range (TWQR) of a 0.5-unit or 15% change from background, with sharp increases in sodium (7.8 to 83.7 mg/l), chloride (12 to 105 mg/l) and potassium, consistent with an influence from treated sewage effluent. Ammonia increased about 85-fold to 6.0 mg N/l, the same as the General Limit Value for wastewater (**Table 4-9**). At the measured pH this corresponds to an estimated 0.036 to 0.052 mg N/l of un-ionised ammonia at 15 to 20 °C, five to seven times the TWQR (0.007 mg/l) and above the Chronic Effect Value (0.015 mg/l), so chronic toxicity to sensitive aquatic biota is likely downstream of the release (DWAF, 1996a). Total inorganic nitrogen rose from about 2.1 to 8.2 mg N/l, from mesotrophic to eutrophic conditions, and COD from 32 to 56 mg/l. Suspended solids were low at both points. Phosphate was below the detection limit (0.05 mg/l) at both points, but this limit is above the mesotrophic range, so the phosphorus status could not be determined. Iron increased from 0.35 to 1.67 mg/l, well above the 10% change allowed. Aluminium was highest upstream (383 µg/l) and exceeded the tentative guideline at both points, which more likely reflects natural sources in the catchment and the analysis of unfiltered samples than the WWTW. Other trace metals were below the laboratory detection limits, but these limits are higher than the TWQRs, so compliance could not be confirmed.

E. coli increased from 90 cfu/100 ml upstream, within the TWQR for full-contact recreation (0–130 counts/100 ml), to 300 cfu/100 ml downstream, in the range where some risk of gastrointestinal illness is indicated if such levels occur frequently (200–400 counts/100 ml; DWAF, 1996b). E. coli is not a direct threat to aquatic biota, but it indicates faecal pollution and, with it, the likely input of organic matter, nutrients and ammonia. The more than threefold increase between the two points therefore points to a faecal input along the reach, consistent with the treated effluent released through the reed bed and runoff from the town. The results come from a single sampling event at the end of the wet season, when dilution is high. The relative influence of the effluent may be greater during lower-flow summer conditions when dilution in the Jan Dissels River is reduced.

Together, the chemical and microbiological results show that, even at the end of the wet season when dilution is greatest, the Jan Dissels River downstream of the WWTW is strongly influenced by treated effluent, and that ammonia is the main water quality concern for aquatic life. The results reflect the effluent before the benefits of the upgrade, and should be confirmed by further sampling at low flow.

Table 4-8: Water quality results for the Jan Dissels River, 29 September 2026 (NviroTek, 2026a, b).

Parameter	Units	Upstream (JD1)	Downstream (JD2)	Guideline (DWAF, 1996a, b)
pH @ 25°C	–	6.55	7.35	Within 0.5 units (or 5%) of background
Electrical Conductivity (EC) @ 25°C	mS/m	< 8.4	59.8	TDS change < 15% from background
Sodium (Na)	mg/l	7.84	83.68	No guideline
Chloride (Cl)	mg/l	12.0	105.0	No guideline
Chemical Oxygen Demand (COD)	mg/l	32	56	No guideline
Total Suspended Solids (TSS)	mg/l	11	10	Increase < 10% of background

Ammonia / Ammonium (as N)	mg/l	0.07	6.00	See un-ionised ammonia
Un-ionised ammonia (as N), estimated*	mg/l	< 0.001	0.036–0.052	TWQR ≤ 0.007; CEV 0.015; AEV 0.1
Nitrate + Nitrite (as N)	mg/l	2.0	2.2	See total inorganic nitrogen
Total inorganic nitrogen (as N)	mg/l	2.1	8.2	< 0.5 oligotrophic; 0.5–2.5 mesotrophic; 2.5–10 eutrophic
Orthophosphate (as P)	mg/l	< 0.05	< 0.05	< 0.005 oligotrophic; 0.005–0.025 mesotrophic; 0.025–0.25 eutrophic
Aluminium (Al)**	µg/l	382.64	86.64	TWQR ≤ 10 (pH > 6.5); CEV 20; AEV 150 (tentative)
Iron (Fe)**	mg/l	0.35	1.67	Change < 10% of background
Manganese (Mn)**	mg/l	0.10	0.11	≤ 0.18
Fluoride (F)	mg/l	< 0.10	< 0.10	≤ 0.75
Zinc, copper, lead, cadmium, mercury**	–	Below detection	Below detection	Detection limits above the TWQR
Dissolved oxygen	–	Not measured	Not measured	80–120% saturation
E. coli	CFU/100 ml	90	300	No aquatic ecosystem guideline; 0–130 for full-contact recreation

Results: NviroTek (2026a, b); the chemistry report is preliminary. *Estimated from total ammonia at the measured pH for a water temperature of 15–20 °C (DWAF, 1996a, Table 1); temperature was not measured. **Total (unfiltered) concentrations; the guidelines refer to dissolved or acid-soluble metals. Guidelines: aquatic ecosystems (DWAF, 1996a); E. coli: full-contact recreation (DWAF, 1996b). The final effluent was not analysed.

Table 4-9: Wastewater limit values for discharge to a water resource (GN 665 of 2013).

Parameter	General Limit	Special Limit
Faecal coliforms (per 100 ml)	1 000	0
Chemical Oxygen Demand (mg/l)	75	30
pH	5.5–9.5	5.5–7.5
Ammonia, ionised and un-ionised (as N) (mg/l)	6	2
Nitrate/Nitrite (as N) (mg/l)	15	1.5
Free chlorine (mg/l)	0.25	0
Suspended solids (mg/l)	25	10
Electrical conductivity (mS/m)	70 above intake, to a maximum of 150	50 above background receiving water, to a maximum of 100
Ortho-phosphate (as P) (mg/l)	10	1 (median) and 2.5 (maximum)

4.7. Aquatic Biota

Fish and aquatic macroinvertebrate information for the sub-quaternary reaches (SQRs) of the Jan Dissels River (E10H-07331) and of the Olifants River downstream of the confluence (E10J-07292) was obtained from the DWS (2014) desktop PES/EIS assessment. Both reaches are rated PES D (Largely Modified) with an integrated EIS of Very High; ecological importance is rated High for the Jan Dissels reach and Moderate for the Olifants reach, and ecological sensitivity Very High for both.

The Jan Dissels SQR is about 40 km long and runs from the largely natural headwaters in the Cederberg to the confluence. Its lower section is affected by irrigation for vineyards near Clanwilliam, the town itself, invasion by alien trees such as blue gums and Port Jackson, and severe channel and bank modification near the town (DWS, 2014). The data for this SQR therefore largely reflect the more natural upper river, and the biota of the reach at the site are likely to be poorer. The Olifants SQR (about 6.6 km) is affected by extensive citrus cultivation, off-channel dams, removal of riparian vegetation, invasion by blue gums and high water abstraction (DWS, 2014).

Fish. The DWS (2014) fish records for the Jan Dissels SQR come from two sites in the upper catchment, well upstream of Clanwilliam. They recorded Barnard's rock catfish (*Austroglanis barnardi*, Endangered), Clanwilliam rock catfish (*Austroglanis gilli*, Near Threatened), Clanwilliam redfin (*Sedercypris calidus*, formerly *Barbus calidus*, Near Threatened) and Cape galaxias (*Galaxias zebratus*), together with the alien smallmouth bass (*Micropterus dolomieu*) and banded tilapia (*Tilapia sparrmanii*), which is not native to the Olifants system. The two rock catfishes and the Clanwilliam redfin are endemic to the Olifants–Doring system; the statuses given are those of the IUCN Red List (IUCN, 2025). No fish data are available for the reach at Clanwilliam, which is more modified, and whether these indigenous species occur there must be confirmed by the fish baseline survey required before construction (Section 6).

No fish records are listed for the Olifants SQR below the confluence. The nearest site, on the Olifants River at Clanwilliam just upstream of the confluence (E10G-07341), recorded three species endemic to the Olifants–Doring system: Clanwilliam yellowfish (*Labeobarbus seeberi*, Near Threatened), Clanwilliam sawfin (*Cheilobarbus serra*, Near Threatened) and Clanwilliam sandfish (*Labeo seeberi,* Endangered, also listed under the national TOPS regulations). It also recorded several alien species: bluegill sunfish, smallmouth, spotted and largemouth bass, and banded tilapia (DWS, 2014). The threats to these fish include alien predatory fish, water abstraction, habitat degradation and pollution, so the water quality and flow in the Jan Dissels and Olifants rivers are relevant to their conservation.

Macroinvertebrates. The DWS (2014) assessment expects 29 macroinvertebrate taxa in the Jan Dissels SQR (high confidence) and 34 in the Olifants SQR (moderate confidence), and rates the sensitivity of the expected macroinvertebrates to changes in flow and water quality as high in both. The taxa expected in the Jan Dissels include several that are sensitive to flow and water quality, such as Notonemouridae (stoneflies), Teloganodidae and Leptophlebiidae (mayflies), Barbarochthonidae and Sericostomatidae (caddisflies) and Helodidae (beetles). A River Health Programme site at the Jan Dissels River bridge at Clanwilliam (E1JAND-BRIDG) recorded 19 families, including Notonemouridae, Teloganodidae, Leptophlebiidae, Baetidae (more than two species), Platycnemidae and Helodidae, which shows that sensitive taxa occurred close to the town when it was sampled. The taxa expected in the Olifants SQR include more taxa typical of slower, warmer water, such as snails (Ancylidae, Lymnaeidae, Physidae), leeches and water bugs, alongside some sensitive taxa such as Tricorythidae (mayflies).

These data show that the Jan Dissels River supports sensitive and endemic biota, at least in its upper reaches, and its importance as an instream migration link is rated Very High (DWS, 2014). The reach below the WWTW connects these upper reaches with the Olifants River, so the quality of the effluent and of the stormwater leaving the site matters beyond the reach itself. The data support the SASS5 and fish baseline surveys required before construction and the biomonitoring in the monitoring plan (Section 6), which will establish the condition of the biota in the reach at Clanwilliam.

5. Impact Assessment

5.1. Stormwater Infrastructure

Runoff from about 1 277 erven, roads and community facilities will be concentrated at 21 headwalls and four attenuation ponds (UDS Africa, 2026b), several of which discharge into or next to the retained central valley bottom wetland system. During construction, the outlet, pipe trench and pond footprints will disturb wetland and buffer habitat and expose soil to erosion, with a risk of sediment, cement and hydrocarbons reaching the wetland. Pond 7 alone, which forms part of the central valley-bottom wetland system, has a storage volume of about 4 850 m³.

In operation, the main impact is a change in the hydrological regime of the valley bottom wetland system. Increased and more frequent inflows can lengthen the period of saturation, favouring *Typha capensis* over seasonal wetland vegetation, and concentrated inflows risk channel incision that would convert parts of the unchannelled wetland into a channelled system. EnviroSwift (2025) noted this risk unless post-development flows are limited to pre-development levels. Poorly dissipated outlets can cause scour and headcut erosion, and urban runoff will carry sediment, litter, hydrocarbons, nutrients and faecal bacteria into the wetland.

If appropriately designed as a treatment train and implemented together with the Rehabilitation Plan, the proposed stormwater system provides an opportunity to improve the current condition and functioning

of the wetland. The wetland is already highly influenced by urban stormwater and effectively forms part of the existing stormwater drainage system, receiving unmanaged runoff and other impacts from the developed areas upslope. UDS intends to incorporate and treat stormwater from the existing informal settlement that currently enters the valley-bottom wetland system untreated (C. Louw, pers. comm., 25 September 2026). This, together with rehabilitation of the wetland, could improve the quality of water entering the system and reduce some of the existing impacts.

The intention should therefore not be to remove the wetland from the stormwater system, but to rehabilitate it so that it functions more effectively as a wetland within this already modified urban setting. Rehabilitation should improve vegetation cover, reduce erosion and channelisation, and promote the spreading and slowing of flows through the valley bottom. This would improve the wetland's ability to provide ecosystem services such as flow attenuation, sediment trapping, nutrient assimilation and water-quality enhancement, while also improving wetland habitat.

The wetland ultimately drains towards the Jan Dissels River and its associated floodplain. Given the very high ecological importance and sensitivity of the Jan Dissels River, the combined stormwater and wetland rehabilitation design should aim to improve both the quality and the hydrological characteristics of water leaving the site. Adequate attenuation and energy dissipation at stormwater outlets, together with rehabilitation of the receiving wetland, are therefore important to reduce erosion, manage peak flows and improve the quality of water ultimately reaching the Jan Dissels River.

5.2. WWTW Refurbishment and Expansion

Effluent quality. Effluent compliance has been poor in every assessment from 2011 to the 2023/24 Green Drop audit, when microbiological compliance was 0% (BVi, 2024; DWS, 2022; 2026), and no results since the refurbishment were available. Effluent quality is a property of the works as a whole rather than of each source of sewage, so it is assessed for the upgraded works in one impact. The housing development would contribute about 18% of the load on the upgraded works (about 640 of 3 600 m³/day), and BVi (2024) found that the existing works could not accommodate the housing development's flow without being repaired and upgraded. Sampling in September 2026 (Section 4.6) showed that the river downstream of the works is already strongly influenced by treated effluent: ammonia increased from 0.07 to 6.0 mg N/l, with estimated un-ionised ammonia above the Chronic Effect Value for aquatic ecosystems, EC increased at least sevenfold, inorganic nitrogen reached eutrophic levels and E. coli increased from 90 to 300 cfu/100 ml. Although the receiving reach is already impacted, an expanded works operating without the recommended mitigation would discharge a larger volume of poor-quality effluent to a river of Very High ecological importance and sensitivity, so the impact is of High significance before mitigation. The aim of the refurbishment and upgrade is to treat the effluent to the Special Limit Values, including COD below 30 mg/l, ammonia below 2 mg/l and phosphate below 1 mg/l (BVi, 2024). If this is achieved, the quality of effluent reaching the Jan Dissels River will improve substantially compared with the status quo. This is a positive impact, and the refurbishment and upgrade of the works are therefore supported and encouraged. It is, however, a design objective rather than a certain outcome. Although the existing plant has been refurbished (C. Louw, pers. comm., 25 September 2026), BVi (2024) notes that oxidation ditch plants are maintenance-intensive, and compliance will depend on operation, maintenance, backup power and funding. Given the long history of non-compliance at the works, the additional capacity of the new module will need additional support, in the form of skilled staff, specialist oversight, maintenance and funding, to be operated to the Special Limit Values. Process failures that release ammonia, organic load, nutrients and faecal bacteria, and residual chlorine from disinfection is toxic to aquatic life. Construction also carries a risk of temporary deterioration or bypassing while units are refurbished and tied in.

Effluent volume. The existing WWTW has a stated design capacity of about 2.4 Ml/day and was receiving about 2.2 to 2.26 Ml/day at the time of the BVi (2024) assessment. The proposed works include a new 1.5 Ml/day treatment module, and the upgraded works is intended to accommodate at least 3.6 Ml/day under peak conditions (BVi, 2024; C. Louw, pers. comm., 25 September 2026). Inflow will grow gradually as the town grows over about 15 years. Part of the effluent is used to irrigate the golf course all year, and the rest drains through the reed bed associated with the southern seep to the Jan Dissels River. DWS (2022) reports that about 80% of the effluent was irrigated and 20% discharged to the Jan Dissels River. Applied to the flow reported at the time (about 2.1 Ml/day, 70% of a design capacity of 3 Ml/day), this indicates that roughly 0.4 Ml/day (about 5 l/s) reached the river. In the absence of a future water balance, a conservative scenario has been adopted in which the full additional treatment capacity of 1.5 Ml/day (about 17 l/s) could ultimately be discharged towards the Jan Dissels River. This is a theoretical upper-bound scenario rather than the predicted discharge, as part of the treated effluent is expected to continue to be reused for irrigation. Because the town's potable water is abstracted upstream, treated effluent may make up a large share of the flow in the receiving reach in summer. A sustained increase in discharge can alter the flow regime of the river, for example by maintaining flow in reaches that would naturally dry to pools in summer, and reduces the dilution available where natural flow is low. The receiving reach is, however, not natural: below the reed bed associated with the southern seep, the river flows for about 4.7 km past the eastern edge of Clanwilliam and through farmland before joining the Olifants River below Clanwilliam Dam, and it is more disturbed than the reach upstream of the works (Section 4.1). This moderates the significance of a change in flow. The reed bed associated with the southern seep provides some polishing before the effluent reaches the river, and the southern seep is expected to enlarge with the increased flow. The water chemistry at the downstream point (Section 4.6) suggests that treated effluent already made up a large share of the flow there at the end of the wet season. If DWS require a hydrological assessment for the expansion of the WWTW, this report may need to be updated.

Housing development share. The effluent generated by the housing development itself is a separate and much smaller quantity than the full expansion. BVi (2024) estimated that the originally proposed 1 158 stands would generate about 579 m³/day of sewage, about 0.5 m³/day per stand. Applying the same per-stand allowance to the current layout of about 1 277 erven gives an indicative flow of about 640 m³/day (about 7.4 l/s), or just over 40% of the new 1.5 Ml/day module, with the rest of the module providing for about 15 years of growth of the town (C. Louw, UDS Africa, pers. comm., 25 September 2026). If the 80:20 split reported by DWS (2022) continued, about 130 m³/day (1.5 l/s) of this would reach the river, and in the upper-bound scenario all 640 m³/day (7.4 l/s). The flow impacts of the housing development and of the full expansion are therefore assessed separately, as Impacts 8a and 8b (**Table 5-1**).

Flow context. Van der Berg (2008)[1] reports that the Jan Dissels River has a mean annual runoff of about 43 million m³, with low flows from December to March. The upper catchment is near-pristine, but the lower river is in a poor (Category D) state because of abstraction and agriculture: about 3.3 million m³ a year is abstracted for agriculture and 0.8 million m³ by the municipality and the town furrow, and the ecological Reserve is not met at the lower end of the river for at least three months of the year, when more than 400 000 m³ would need to be freed up to meet it. This is consistent with the site assessment, which found that the Jan Dissels floodplain downstream of the potable water abstraction point appears to have dried out.

In this context, given the extent of abstraction from the lower Jan Dissels River, the additional discharge could be seen as partly returning water to a reach whose dry-season flows are already below the ecological requirement, and it is unlikely to create excessive flows at a catchment scale. This interpretation

[1] The study dates from 2008; abstraction and flows may have changed.

is, however, limited. No current flow or abstraction data, or water balance for the works, were available; the abstraction figures date from 2008 and may have changed; and the timing of future discharges relative to the dry-season deficit is unknown. In addition, treated effluent cannot be regarded as equivalent to natural ecological flow. It differs in quality, temperature, timing and seasonality, it enters the river at a single point, and the water quality results (Section 4.6) show that it already has a substantial influence on the river. As broad catchment context only, the full additional capacity of 1.5 Ml/day would amount to about 1.3% of the mean annual runoff over a year (about 0.5% for the housing development). The relative contribution of the effluent, and its effect, will however be greatest during the December to March low-flow period, which an annual average does not reflect. The quality of the effluent (Impact 7) therefore remains the main concern, together with its share of the summer low flow. Van der Berg (2008) also recommended that the town's dry-season abstraction be switched from the Jan Dissels River to Clanwilliam Dam.

Olifants River. The Jan Dissels River joins the Olifants River about 4.7 km downstream of the effluent release, just below Clanwilliam Dam (Van der Berg, 2008). This reach of the Olifants is not pristine: its flow is regulated by the dam, its PES was rated between D - F[2] in the NBA 2018 (Van Deventer et al., 2019), and its floodplain wetland is largely modified (PES D; **Table 4-1**), although its EIS is Very High (Table 4-7). The additional effluent is small relative to the combined flow of the Jan Dissels and the regulated Olifants, so a measurable change in the flow of the Olifants is unlikely (Impact 11). Water quality impairment is possible, mainly from ammonia and nutrients carried down the Jan Dissels at low flow, although uptake in the reed bed associated with the southern seep and Jan Dissels River, nitrification over 4.7 km and dilution at the confluence would reduce concentrations (Impact 10)[3].

Southern seep. The southern seep below the golf course receives the treated effluent released from the works and has done so for many years. Its hydrology and water quality are already critically modified (F), and it is now sustained to a large degree by the effluent (Section 4.2). The additional effluent will therefore not introduce a new type of impact, which reduces the significance of the impacts on the seep. However, as the volume released increases with the growth of the town over about 15 years, the seep is likely to stay saturated for longer and to increase in extent (Impact 12). This can be reduced by irrigation reuse and storage, but not avoided. The quality of the water in the seep will continue to depend on that of the effluent (Impact 13). If the upgraded works meets the Special Limit Values, the quality of the water entering the seep will improve compared with the status quo, while process failures would continue to affect it directly. As the seep expands, its capacity to polish the effluent before it reaches the Jan Dissels River is also likely to increase. Both impacts on the seep are therefore of Low significance, given the degree of disturbance it already exhibits (hydrology and water quality critically modified, PES E).

Golf course irrigation. Soils and turf can retain suspended solids and part of the organic load and take up nutrients, but how much depends on irrigation rates relative to turf demand, soils, depth to groundwater and distance to the watercourse, none of which have been quantified. The golf course lies next to and partly within the wetland system, so over-irrigation, or irrigation in winter, would carry nutrients, salts and bacteria to the central valley bottom wetland system and ultimately to the Jan Dissels River. Irrigation is therefore not relied on as mitigation in this addendum. DWS (2026) also observed final effluent overflowing at the works because the golf course was not taking enough for irrigation, which shows that the volume irrigated is limited by demand[4]. Under GN 665 (Government Gazette 36820, 6 September 2013), the

[2] This PES is associated with where the Olifants River has been transformed into the Clanwilliam Dam.
[3] No water quality data are available for the Olifants River at the confluence.
[4] No exact date is provided.

irrigation of land with treated domestic and biodegradable industrial wastewater is subject to specific limits and conditions. The General Authorisation permits the irrigation of up to 2 000 m³/day of wastewater, provided that the applicable water quality standards and other conditions of the authorisation are met. The irrigation area must also comply with specified separation distances from water resources and other sensitive features, including the 1:100-year floodline or riparian habitat, a minimum 100 m from a watercourse, more than 500 m from boreholes used for drinking water or stock watering, and outside a 500 m radius of a wetland. The irrigation system must be managed to prevent waterlogging, pooling, contaminated runoff and contamination of nearby water resources. The volume of wastewater used for irrigation must be monitored and recorded to demonstrate compliance with the applicable limits.

The golf course lies next to and partly within the central valley bottom wetland system and the southern seep and is to be extended, so the irrigation cannot meet these separation distances and must be authorised under a water use licence (section 21 (e)) rather than the General Authorisation.

5.3. Cumulative Impacts

The wetlands and the Jan Dissels River already receive stormwater from the existing town / informal settlement, runoff from the town and farmland along the river downstream, poor-quality effluent from the WWTW, and pressure from dumping and alien invasive plants. The new stormwater discharges and higher effluent volume add to these, while the WWTW upgrade and the wetland rehabilitation can reduce them.

5.4. Impact Significance

Table 5-1 summarises the significance of each impact before and after mitigation, and the detailed scoring is given in **Annexure C**. These ratings are preliminary and precautionary. They take into account that the central valley bottom wetland and the southern seep are seriously modified (PES E) and of Moderate EIS, and that the Jan Dissels River is largely modified (PES D), of Very High EIS and part of a CBA 1 corridor that joins the Olifants River (Very High EIS) about 4.7 km downstream of the WWTW (Section 4).

The water quality results (Section 4.6) show that the effluent already affects the Jan Dissels River, so the likelihood of Impact 7 without mitigation has been raised from likely to definite. Given the larger volume of effluent from the expanded works, the long record of non-compliance and the Very High ecological importance and sensitivity of the river, Impact 7 is of High significance before mitigation (3.83). Impact 7 remains of Medium significance after mitigation (2.61), rather than Low, because of the long history of non-compliance at the works and because the additional capacity will require additional operational support (Section 5.2). The southern seep and historical non-perennial river south-east of the WWTW, which receive the treated effluent, are already seriously to critically modified (water quality F; riparian IHI F), and the floodplain wetlands are largely modified (PES D). The floodplain wetlands are covered by Impacts 7, 8a and 8b. The southern seep is assessed separately (Impacts 12 and 13) because it is likely to expand as the volume of effluent increases; both impacts are of Low significance, given the degree of disturbance it already exhibits (hydrology and water quality critically modified, PES E). The results do not change the other ratings, which will be reviewed again if post-refurbishment effluent results become available and show that special limits are met, Impacts 8a and 8b take into account the existing over-abstraction of the lower Jan Dissels River (Van der Berg, 2008), Impacts 10 and 11 cover the Olifants River downstream of the confluence, and Impacts 8a and 8b have been rated on the conservative upper-bound flow scenario described in Section 5.2.

During construction, disturbance of wetland habitat, erosion and sedimentation, and water quality impairment are of Medium significance before mitigation. Building the piped connection within the central valley-bottom wetland system, outlets and proposed Rehabilitation activities will disturb wetland habitat, the sandy soils of the site erode easily, and tie-ins at the WWTW carry a risk of untreated sewage reaching

the Jan Dissels River. With no-go areas, dry-season construction, sediment controls and a contingency plan for the WWTW tie-ins, all three are reduced to Low significance.

During operation, the altered hydrological regime of the wetlands, erosion at the outlets, urban stormwater quality and nutrient loading from irrigation are of Medium significance before mitigation and Low after mitigation. This depends on peak flows being attenuated to pre-development levels, outlets discharging diffusely through energy dissipators, a stormwater treatment train being installed and maintained, and irrigation being matched to turf demand.

Treated effluent quality (Impact 7) is of High significance before mitigation, reflecting the poor compliance record of the works in every assessment since 2011 (Section 2.2) and the larger volume of effluent from the expanded works. Mitigation reduces it to Medium significance (from 3.83 to 2.61), but not to Low. Given the history of non-compliance, and because the additional capacity will need additional operational support, compliance with the Special Limit Values cannot be assumed. The refurbishment and upgrade of the works, which aim to treat the effluent to the Special Limit Values, would be a positive impact compared with the status quo and are encouraged.

The change in flow in the Jan Dissels River associated with the housing development itself (Impact 8a) is of Medium significance before mitigation and Low significance after mitigation. The housing development is expected to contribute approximately 640 m^3/day, of which only a portion is likely to reach the river while treated effluent continues to be reused for irrigation. The lower Jan Dissels River is also already affected by abstraction, with historical information indicating that summer flows fall below the ecological Reserve. On this basis, the additional flow attributable specifically to the housing development is unlikely to result in a significant alteration of the receiving river after mitigation.

The change associated with the full expansion of the WWTW (Impact 8b) remains of Medium significance after mitigation. The additional 1.5 Ml/day treatment capacity provides for broader growth of Clanwilliam over approximately 15 years and represents a larger and progressively increasing change in discharge. In the absence of a water balance and current river-flow data, the proportion that will ultimately reach the Jan Dissels River cannot be reliably quantified. A precautionary Medium residual significance is therefore retained for the full expansion. The lower Jan Dissels River is already over-abstracted and its summer flows fall below the ecological Reserve (Van der Berg, 2008), so the additional discharge is unlikely to create excessive flows and could be seen as partly offsetting the dry-season deficit, although this cannot be confirmed without current flow and abstraction data. Treated effluent is, however, not equivalent to natural flow, and its quality remains the main concern (Impact 7).

Water quality impairment in the Olifants River downstream of the confluence (Impact 10) is of Medium significance before mitigation and Low after mitigation, and a change in its flow (Impact 11) is of Low significance, because the Olifants is regulated by Clanwilliam Dam and the additional effluent is small relative to its flow.

The increase in effluent volume is likely to lengthen saturation and increase the extent of the southern seep as the town grows (Impact 12), and the quality of the water in the seep will continue to depend on that of the effluent (Impact 13). Both are of Low significance before and after mitigation, given the degree of disturbance it already exhibits (hydrology and water quality critically modified, PES E).

Table 5-1: Summary of impact significance.

Impact	Phase	Without mitigation	With mitigation	Key mitigation
1. Disturbance of wetland habitat (stormwater construction)	Construction	Medium (2.74)	Low (2.03)	No-go areas; narrow working width; dry-season construction
2. Erosion and sedimentation of the wetlands	Construction	Medium (2.83)	Low (1.90)	Sediment controls; rehabilitation
3. Water quality impairment during construction, incl. WWTW works	Construction	Medium (2.95)	Low (2.05)	No bypass; contingency plan; spill control
4. Altered hydrological regime of Central VBW and Southern Seep	Operation	Medium (3.18)	Low (2.50)	Attenuation to pre-development peaks; diffuse discharge
5. Erosion at stormwater outlets	Operation	Medium (2.79)	Low (1.64)	Energy dissipators; maintenance
6. Water quality impairment from urban stormwater	Operation	Medium (3.25)	Low (2.50)	Treatment train; litter traps
7. Treated effluent quality in the Jan Dissels River	Operation	High (3.83)	Medium (2.61)	Special Limit compliance; specialist process engineer and works manager; additional operational support; periodic effluent monitoring; chlorine control
8a. Altered flow regime of the Jan Dissels River from the housing development's effluent	Operation	Medium (2.96)	Low (2.32)	Irrigation reuse matched to demand; volume metering; water-efficient fittings
8b. Altered flow regime of the Jan Dissels River from the full expansion of the WWTW	Operation	Medium (3.03)	Medium (2.71)	Water balance; storage; irrigation reuse; volume metering
9. Nutrient and salt loading from golf course irrigation	Operation	Medium (3.15)	Low (2.40)	Irrigation management plan
10. Water quality impairment in the Olifants River downstream of the confluence	Operation	Medium (2.98)	Low (2.37)	Special Limit compliance; reed bed retention; monitoring above and below the confluence
11. Altered flow regime of the Olifants River downstream of the confluence	Operation	Low (2.37)	Low (2.27)	Volume metering; water balance
12. Altered hydrological regime and extent of the southern seep	Operation	Low (2.35)	Low (2.20)	Water balance; irrigation reuse and storage; diffuse release through

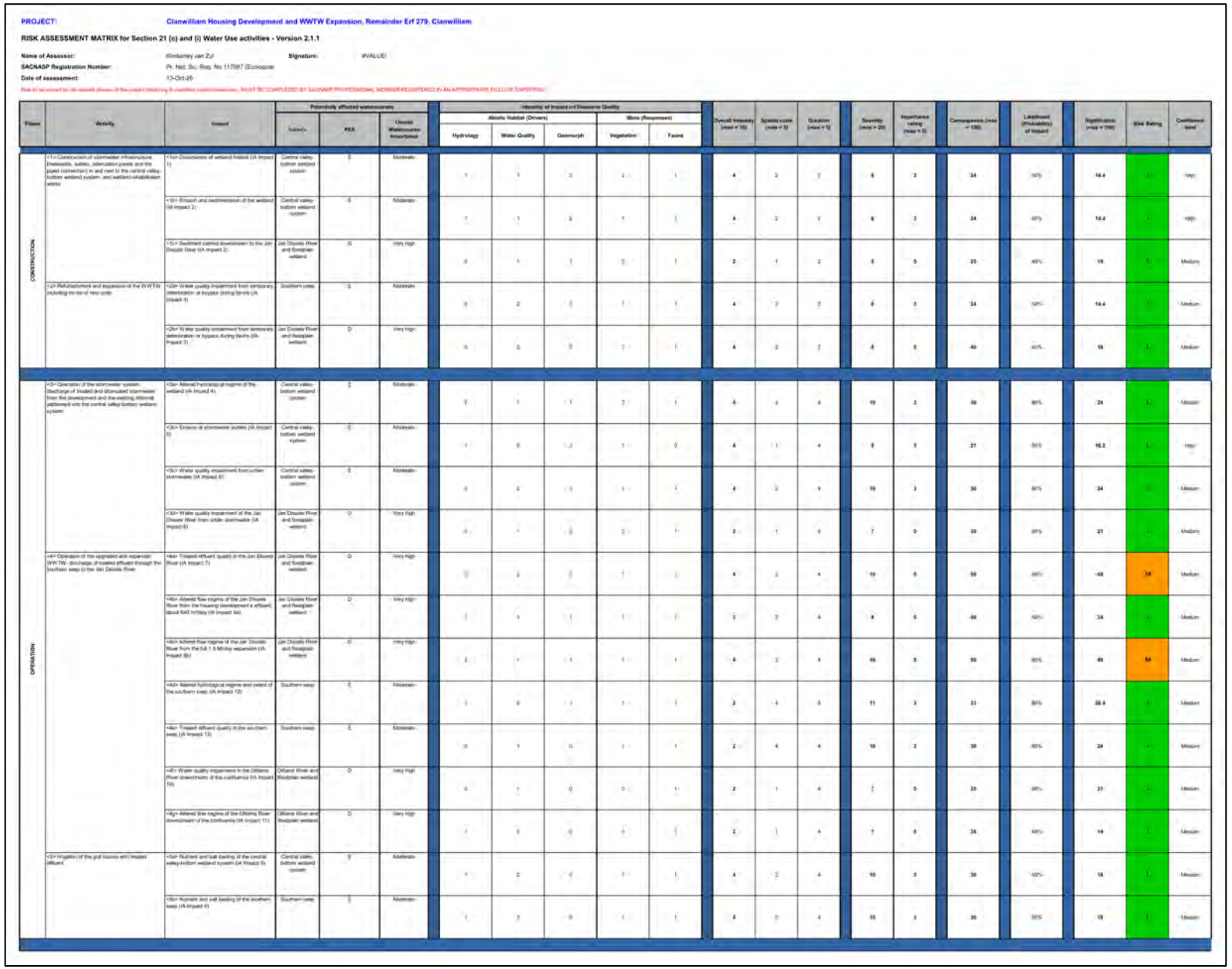
				the reed bed; annual mapping of the seep
13. Treated effluent quality in the southern seep	Operation	Low (2.45)	Low (2.20)	Special Limit compliance; specialist process engineer and works manager; effluent monitoring

Under the no-go alternative, the central valley bottom wetland would remain unrehabilitated and would continue to receive unmanaged stormwater from the informal settlement and township, and the existing WWTW, which has a long record of non-compliant effluent, would continue to operate close to its capacity as the town grows. This is a continuing negative impact of Medium significance on the wetland and the Jan Dissels River.

5.5. Risk Assessment

The Risk Assessment Matrix (RAM) of GN 4167 of 2023 (DWS, 2023a) was applied to the stormwater and WWTW activities, and its outcome mirrors the impact assessment (Section 5.4; **Annexure A**). Activities whose impacts are of Low significance after mitigation have a Low risk, and those whose impacts remain of Medium significance after mitigation have a Moderate risk. The quality of treated effluent reaching the Jan Dissels River (Impact 7) and the change in flow from the full expansion of the works (Impact 8b) remain of Moderate risk after mitigation. Only activities with a Low risk can be authorised under the General Authorisation for section 21 (c) and 21 (i) water uses (DWS, 2023a).

A full Water Use Licence Application (WULA) is therefore required for the section 21 (c) and 21 (i) water uses associated with the development, the stormwater infrastructure and the WWTW. The discharge of treated effluent to the Jan Dissels River and the irrigation of the golf course with treated effluent are section 21 (f) and 21 (e) water uses that also require a water use licence (BVi, 2024).



PROJECT: Clanwilliam Housing Development and WWTW Expansion, Remainder Erf 279, Clanwilliam

RISK ASSESSMENT MATRIX for Section 21 (c) and (i) Water Use activities - Version 2.1.1

Name of Assessor: Kimberley van Zyl | Signature: #VALUE!

SACNASP Registration Number: Pr. Nat. Sci. Reg. No 117097 (Ecologist)

Date of assessment: 13-Oct-25

Phase	Activity	Impact	Potentially affected watercourses: Name	PES	Overall Watercourse Importance	Intensity of Impact and Resource Quality: Abiotic Habitat (Drivers): Hydrology	Water Quality	Geomorph	Biota (Responses): Vegetation	Fauna	Overall Intensity (max = 10)	Spatial scale (max = 5)	Duration (max = 5)	Severity (max = 20)	Importance rating (max = 5)	Consequence (max = 100)	Likelihood (Probability) of Impact	Significance (max = 100)	Risk Rating	Confidence level
CONSTRUCTION	<1> Construction of stormwater infrastructure (headwalls, outlets, attenuation ponds and the piped connection) in and next to the central valley-bottom wetland system, and wetland rehabilitation works	<1i> Disturbance of wetland habitat (IA Impact 1)	Central valley-bottom wetland system	E	Moderate-	1	1	0	0	1	4	2	2	8	3	24	60%	14.4	L	Low
		<1ii> Erosion and sedimentation of the wetland (IA Impact 2)	Central valley-bottom wetland system	E	Moderate-	1	1	0	1	1	4	2	2	8	3	24	60%	14.4	L	Low
		<1iii> Sediment carried downstream to the Jan Dissels River (IA Impact 2)	Jan Dissels River and floodplain wetland	D	Very High	0	1	1	0	1	3	1	2	5	5	25	40%	10	L	Medium
	<2> Refurbishment and expansion of the WWTW including re-use of new pond	<2i> Water quality impairment from temporary deterioration or bypass during tie-ins (IA Impact 3)	Southern seep	E	Moderate-	0	0	0	1	1	4	2	2	8	3	24	60%	14.4	L	Medium
		<2ii> Water quality impairment from temporary deterioration or bypass during tie-ins (IA Impact 3)	Jan Dissels River and floodplain wetland	D	Very High	0	0	0	1	1	4	2	2	8	5	40	40%	16	L	Medium
OPERATION	<3> Operation of the stormwater system: discharge of treated and attenuated stormwater from the development and the existing informal settlement into the central valley-bottom wetland system	<3a> Altered hydrological regime of the wetland (IA Impact 4)	Central valley-bottom wetland system	E	Moderate-	1	1	1	2	1	6	2	5	13	3	39	85%	24	L	Medium
		<3b> Erosion at stormwater outlets (IA Impact 5)	Central valley-bottom wetland system	E	Moderate-	1	0	1	1	0	4	1	4	9	3	27	65%	16.2	L	Low
		<3c> Water quality impairment from urban stormwater (IA Impact 6)	Central valley-bottom wetland system	E	Moderate-	0	0	1	1	1	4	2	4	10	3	30	80%	24	L	Medium
		<3d> Water quality impairment of the Jan Dissels River from urban stormwater (IA Impact 6)	Jan Dissels River and floodplain wetland	D	Very High	0	1	0	0	1	2	1	4	7	5	35	60%	21	L	Medium
	<4> Operation of the upgraded and expanded WWTW: discharge of treated effluent through the southern seep to the Jan Dissels River	<4a> Treated effluent quality in the Jan Dissels River (IA Impact 7)	Jan Dissels River and floodplain wetland	D	Very High	0	0	0	1	1	4	2	4	10	5	50	80%	40	M	Medium
		<4b> Altered flow regime of the Jan Dissels River from the Housing development's effluent, about 640 m³/day (IA Impact 8a)	Jan Dissels River and floodplain wetland	D	Very High	1	1	1	1	1	5	2	4	9	5	45	80%	36	L	Medium
		<4c> Altered flow regime of the Jan Dissels River from the full 1.5 Ml/day expansion (IA Impact 8b)	Jan Dissels River and floodplain wetland	D	Very High	2	1	1	1	1	6	2	4	10	5	50	80%	40	M	Medium
		<4d> Altered hydrological regime and extent of the southern seep (IA Impact 12)	Southern seep	E	Moderate-	1	0	1	1	1	3	1	3	11	3	33	80%	26.4	L	Medium
		<4e> Treated effluent quality in the southern seep (IA Impact 13)	Southern seep	E	Moderate-	0	1	0	1	1	2	4	4	10	3	30	80%	24	L	Medium
		<4f> Water quality impairment in the Olifants River downstream of the confluence (IA Impact 10)	Olifants River and floodplain wetland	D	Very High	0	1	0	0	1	2	1	4	7	5	35	60%	21	L	Medium
		<4g> Altered flow regime of the Olifants River downstream of the confluence (IA Impact 11)	Olifants River and floodplain wetland	D	Very High	1	0	0	0	1	2	1	4	7	5	35	40%	14	L	Medium
	<5> Irrigation of the golf course with treated effluent	<5a> Nutrient and salt loading of the central valley-bottom wetland system (IA Impact 9)	Central valley-bottom wetland system	E	Moderate-	1	0	0	1	1	4	2	4	10	3	30	60%	18	L	Medium
		<5b> Nutrient and salt loading of the southern seep (IA Impact 9)	Southern seep	E	Moderate-	1	1	0	1	1	4	2	4	10	3	30	65%	19	L	Medium

Figure 5-1: Risk Assessment Matrix (GN 4167 of 2023) for the stormwater and WWTW activities (see Annexure A for the full RAM).

6. Mitigation and Monitoring

The measures below are needed to achieve the "with mitigation" ratings in **Table 5-1**. They should be included in the EMPr and as conditions of the Environmental Authorisation (EA) and the Water Use Licence (WUL).

6.1. Stormwater

These measures apply both to the new stormwater system and to the stormwater from the existing informal settlement and township that already flows into the central valley-bottom wetland system.

- Design the system so that post-development peak flows to the wetland do not exceed pre-development peaks. The current design attenuates the 1:100-year peak to the post-development 1:2-year peak (UDS Africa, 2026b).
- Treat stormwater before it reaches the wetland with a treatment train: litter and gross pollutant traps upstream of every headwall, vegetated swales or filter strips where space allows, and a settling pond or sediment forebay at the inlet to each pond. Because Pond 7 forms part of the central valley-bottom wetland system, a vegetated settling pond or forebay, with a shallow permanent wetland zone planted with indigenous wetland species, must be provided before stormwater is discharged into it, so that low flows are polished as well as peaks attenuated.
- Intercept and treat the stormwater from the existing informal settlement and township before it enters the central valley-bottom wetland system, as UDS Africa propose (C. Louw, pers. comm., 25 September 2026), with litter traps and a sediment forebay as a minimum. This is the main source of pollution in the wetland at present.
- Place headwalls outside the wetland, and preferably outside the 15 m buffer. Fit every outlet with an energy dissipator (for example a stilling basin, riprap apron or gabion mattress) and a level spreader, so that water enters the wetland as diffuse flow and never as a concentrated jet.
- Set the levels and capacity of the piped connection between the upper part (Wetland 1) and lower part (Wetland 2) of the central valley-bottom wetland system so that the upper part keeps its natural water levels and only overflow is conveyed; consider an open vegetated channel instead of a pipe.
- During construction: demarcate the wetland and buffer as no-go areas outside approved working areas; build outlets and the piped connection in the dry season; install silt fences and sediment traps downslope of earthworks; keep stockpiles, fuel, cement mixing and vehicle servicing outside the wetland and buffer; keep spill kits on site and clean up spills immediately; and rehabilitate disturbed areas in line with the Wetland Rehabilitation and Management Plan.
- In operation: the municipality must inspect and clean inlets, litter traps, outlets, forebays and ponds at least quarterly and after large storms, remove sediment from forebays before they are half full and dispose of it off site, and repair erosion immediately.
- Provide regular solid-waste collection in the informal settlement and township and clear dumped waste and tyres from the wetland, to reduce the litter and dumping that currently reach it.
- Implement the Wetland Rehabilitation and Management Plan (Delta Ecology, 2026): removal of waste and tyres, clearing of alien invasive plants (including *Acacia saligna*), stabilisation of eroded areas and replanting with indigenous wetland vegetation.

6.2. WWTW

- Complete the refurbishment and upgrade of the works so that the effluent is treated to the Special Limit Values (BVi, 2024). This is supported and encouraged, as it is the main means of improving water quality in the Jan Dissels River.
- Phase construction so that treatment capacity is maintained, with no bypass of untreated sewage to the river, and prepare a contingency plan for failures during tie-ins.
- Operate the works to the Special Limit Values in the water use licence, with working inlet, outlet and irrigation flow meters, backup power, spares, qualified process controllers and a supervisor (none was in place at the 2023/24 Green Drop audit; DWS, 2026), and the operation and maintenance plan proposed by BVi (2024).
- Appoint a suitably qualified and experienced wastewater process engineer to oversee the commissioning of the refurbished and expanded works and to audit its functioning regularly, at least quarterly for the first two years of operation and thereafter at the interval set in the monitoring plan. The audits should cover process performance, effluent compliance, maintenance and staffing, and be reported in writing to the municipality and DWS.
- Appoint a dedicated works manager (site manager), with the appropriate process controller qualifications, to oversee the daily operation and functioning of the works, keep operational records and report any failure or non-compliance immediately.
- Before the new module is commissioned, increase operational support in line with the added capacity: process controllers and maintenance staff on every shift, a dedicated operation and maintenance budget, spares and a planned maintenance schedule. The expanded works will be more demanding to operate than the existing works, which has a long history of non-compliance.
- Monitor the final effluent periodically through an accredited laboratory (see Monitoring below), and confirm that the refurbished works meets the Special Limit Values before the new module is commissioned. If a result exceeds a limit, investigate the cause, take corrective action and resample, and notify DWS as the water use licence requires.
- Repair the chlorine contact channel so that no effluent bypasses disinfection (DWS, 2026), control residual chlorine in the final effluent (dechlorination or optimised dosing), and consider UV disinfection.
- Retain the reed bed below the golf course as a polishing wetland: do not clear or canalise it, keep the effluent spread across it rather than in a single channel, and control alien invasive plants.
- Provide enough storage and pumping capacity that effluent is not forced to overflow when the golf course is not taking it (DWS, 2026), and route any excess through the reed bed rather than directly to the river.
- Prepare an irrigation management plan for the golf course: application matched to turf demand, no irrigation during rain or on saturated soils, setbacks from the wetland and river, and enough storage to avoid forced winter discharge.
- Before the new module is commissioned, prepare a water balance for the works (inflow, irrigation and discharge to the river, by month) for the current flow, the housing development and the full 3.6 Ml/day, as part of the water use licence application.
- Switch the town's dry-season (December to March) potable water abstraction from the Jan Dissels River to Clanwilliam Dam where possible, as recommended by Van der Berg (2008), to help restore summer low flows in the lower river.
- Fit the new houses with water-efficient fittings (for example low-flow taps and showerheads and dual-flush toilets), to reduce both the potable water abstracted from the Jan Dissels River and the volume of effluent produced by the housing development.

6.3. Monitoring

- Monitoring plan: before construction starts, a suitably qualified aquatic specialist and the appointed engineers must prepare a comprehensive monitoring plan for the stormwater system, the wetlands, the WWTW effluent and the Jan Dissels River, for inclusion in the EMPr and the water use licence application. It must set out the monitoring points, parameters, frequencies, thresholds that trigger management action, responsibilities and reporting, and include at least the measures below. It must include biomonitoring of the Jan Dissels River: aquatic macroinvertebrates (SASS5; Dickens and Graham, 2002) and fish (for example with the Fish Response Assessment Index; Kleynhans, 2007), upstream and downstream of the effluent release and of the wetland outflow.
- Baseline: before construction starts, a suitably qualified aquatic specialist must undertake SASS5 and fish surveys of the Jan Dissels River at the monitoring sites upstream and downstream of the effluent release and the wetland outflow, to provide a baseline against which later monitoring is compared.
- Final effluent: at the frequency required by the water use licence, and at least monthly, for the parameters in Table 4-9, analysed by an accredited laboratory, with the results reviewed by the process engineer and reported to the municipality and DWS.
- Stormwater system: record each inspection, clean-out and repair of the litter traps, forebays, ponds and outlets, with photographs.
- Effluent volumes: meter the total treated effluent, the volume drawn off for golf course irrigation (using the existing meter on the draw-off) and the volume released to the reed bed and the Jan Dissels River. Record these daily from commissioning of the new module, together with rainfall, and report them with the water use licence monitoring. After the first year, these records provide a measured water balance and show whether the upper-bound assumption in Section 5.2 holds.
- Jan Dissels and Olifants rivers: water quality upstream and downstream of the effluent release, and in the Olifants River above and below the confluence, monthly for two years after commissioning, then quarterly, with field measurement of temperature, pH, EC and dissolved oxygen and with analytical detection limits below the aquatic ecosystem TWQRs (in particular for phosphate and trace metals); SASS5 and fish sampling twice a year (high and low flow) at the baseline sites. Fish sampling requires a CapeNature permit.
- Wetlands: fixed-point photographs and an annual inspection of erosion at the outlets, and a repeat WET-Health assessment of the central valley-bottom wetland system three and five years after the stormwater system and rehabilitation are complete, to confirm progress towards the Recommended Ecological Category (D).
- Southern seep: map the extent of the seep and reed bed annually, from aerial imagery or a field survey, and relate it to the volumes of effluent released, to track its expansion as flows increase.

7. Conclusion and Reasoned Opinion

The wetland systems associated with the proposed Clanwilliam Housing Development are seriously modified (PES E). The central valley bottom wetland system currently receives substantial volumes of polluted stormwater, and possibly sewage, from the informal settlement and township upslope, which flow through the wetland and on to the Jan Dissels River untreated to a large degree. The southern seep wetland currently receives treated (and for many years untreated) effluent from the WWTW. Water quality sampling showed that the Jan Dissels River downstream of the works is strongly influenced by treated effluent, with ammonia at levels likely to cause chronic toxicity to sensitive aquatic biota, eutrophic nitrogen concentrations and increased E. coli.

The proposed stormwater design, combined with the rehabilitation of the central valley bottom wetland system, is supported, mainly because the water flowing from the wetland system to the Jan Dissels River is expected to be of better quality with formalized stormwater treatment than it is at present. This depends on the stormwater from both the new development and the existing settlement being treated before it enters the wetland, on peak flows being attenuated to pre-development levels, on outlets and ponds being placed outside the wetland and discharging diffusely, and on the system being maintained and the Wetland Rehabilitation and Management Plan being implemented.

The refurbishment and upgrade of the WWTW aim to treat the effluent to the Special Limit Values. They are expected to improve the quality of treated effluent reaching the Jan Dissels River compared with the long record of non-compliance at the works, and are supported and encouraged. Without mitigation, the effluent quality impact of the expanded works is of High significance. However, given the history of non-compliance, and because the additional capacity will need additional operational support, the impact of effluent quality to the Jan Dissels River remains of Medium significance after mitigation. Compliance must be secured through a specialist process engineer, a dedicated works manager and regular effluent monitoring. The increased discharge will also alter the flow in the river from the current status quo. This reach of the Jan Dissels River is already affected by the abstraction of potable water for the town upstream of the effluent release, and its floodplain downstream of the abstraction point has dried out, and the growth of the town that the expansion provides for over the next 15 years is likely to require additional abstraction. Downstream of the works the river is not natural: it flows past the town and through farmland for about 4.7 km before joining the Olifants River. These factors moderate the significance of the change in flow. The Olifants River, which the Jan Dissels joins about 4.7 km downstream of the release, is regulated by Clanwilliam Dam and is unlikely to be measurably affected in flow, although some water quality impairment is possible.

Two separate quantities need to be considered: the treated effluent generated by the housing development itself, estimated at about 640 m^3/day, and the full 1.5 Ml/day expansion of the works, which provides for the growth of the town. These are assessed separately as Impacts 8a and 8b. After mitigation, the housing development's share is of Low significance, because it is small, only part of it is likely to reach the river while effluent continues to be reused for irrigation, and the lower river is already affected by abstraction. The full expansion remains of Medium significance on a precautionary basis, because it is larger and increases progressively, and without a water balance and current flow data the proportion reaching the river cannot be reliably quantified. Given the extent of abstraction, the additional discharge could be seen as partly offsetting the existing dry-season flow deficit in the lower Jan Dissels River (Van der Berg, 2008), but this cannot be confirmed without current flow and abstraction data, and the quality of that water remains the main concern. The southern seep, which has received effluent for many years, is likely to expand as the volume increases, but this is of Low significance, given the degree of disturbance it already exhibits (hydrology and water quality critically modified, PES E). A water balance would show

how much of each reaches the river, but it was not available for this assessment, so the change in flow has been assessed using a conservative upper-bound scenario. If DWS require a hydrological assessment for the expansion of the WWTW, this report may need to be updated.

It is the opinion of the specialist that the proposed Clanwilliam Housing Development, including its stormwater infrastructure and the associated refurbishment and expansion of the Clanwilliam WWTW, is acceptable from an aquatic biodiversity perspective and may be authorised. This is on condition that the mitigation measures in Section 6 are implemented and that the upgraded WWTW consistently meets the Special Limit Values for discharge to the Jan Dissels River.

The development will formalise housing for residents of the existing informal settlement, whose untreated stormwater, waste and possibly sewage currently drain into the central valley-bottom wetland system and on to the Jan Dissels River. Formal services, the treatment of stormwater from both the new development and the existing settlement, and the rehabilitation of the wetland offer a real opportunity to improve the condition of the wetland and the quality of water reaching the river. The refurbishment and upgrade of the WWTW, which has a long record of non-compliance, is likewise necessary, and is expected to improve the quality of the effluent reaching the Jan Dissels River compared with the status quo. Neither benefit is assured, however. The quality of treated effluent reaching the Jan Dissels River and the change in flow from the full expansion of the works remain of Medium significance after mitigation, and the river downstream of the works is already strongly influenced by effluent. Careful implementation of the recommended mitigation, monitoring and oversight is therefore essential. The following should be conditions of the environmental authorisation and the water use licence:

- The upgraded WWTW must be operated to meet the Special Limit Values (GN 665 of 2013) for discharge to the Jan Dissels River, and the refurbished works must be shown to meet them before the new module is commissioned.
- A suitably qualified wastewater process engineer must oversee the commissioning of the works and audit its performance, a dedicated works manager must be appointed, and staff, maintenance and funding must be increased in line with the additional capacity.
- A full WULA must be submitted for the section 21 (c) and 21 (i) water uses, together with the section 21 (e) and 21 (f) uses, and must include a monthly water balance for the works (inflow, irrigation and discharge to the river).
- The stormwater system must attenuate post-development peak flows to pre-development levels, treat stormwater from both the new development and the existing informal settlement before it enters the wetland, and place outlets and any new ponds outside the wetland where possible, with a settling pond or forebay before the discharge into the wetland at Pond 7, energy dissipation and diffuse discharge.
- The Wetland Rehabilitation and Management Plan (Delta Ecology, 2026) must be implemented for the central valley-bottom wetland system, to achieve its REC of D, and the reed bed of the southern seep must be retained as a polishing wetland.
- An irrigation management plan must be prepared for the golf course.
- Before construction starts, a suitably qualified aquatic specialist and the appointed engineers must prepare a comprehensive monitoring plan, covering effluent quality and volumes, water quality upstream and downstream of the works and in the Olifants River, SASS5 and fish, and the extent of the southern seep. SASS5 and fish baseline surveys must be completed before construction. Monitoring results must be reported to DWS and the municipality.
- An Environmental Control Officer must oversee construction and compliance with the EMPr.

If post-refurbishment effluent results, the water balance or a hydrological assessment required by DWS show conditions materially different from those assumed in this addendum, the assessment should be reviewed.

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Annexure A: DWS Risk Assessment

The RAM of GN 4167 of 2023 (version 2.1.1) was completed for the construction and operational phases of the stormwater and WWTW activities, with the control measures in Section 6 assumed to be in place. The PES and importance of the watercourses were taken from Section 4: Moderate for the central valley-bottom wetland system and the southern seep, and Very High for the Jan Dissels and Olifants rivers (DWS, 2014). The results mirror the impact assessment (Table 5-1 and Annexure C). The effluent quality in the Jan Dissels River and the change in flow from the full expansion of the works are of Moderate risk (significance 40), and all other activities are of Low risk. Because two activities have a Moderate risk, the section 21(c) and 21(i) water uses cannot be authorised under the General Authorisation, and a full WULA is required (Section 5.5). The completed RAM is reproduced below (Figure A-1 to Figure A-4) and is also provided as a separate spreadsheet (Risk-Assessment-Matrix_Clanwilliam Housing Development.xlsx).

PROJECT: Clanwilliam Housing Development and WWTW Expansion, Remainder Erf 279, Clanwilliam

RISK ASSESSMENT MATRIX for Section 21 (c) and (i) Water Use activities (Version 2.1.1)

POTENTIALLY AFFECTED WATERCOURSE/S			FIELD-VERIFIED ASSESSMENT RESULTS				
Watercourse number	Watercourse name	Watercourse type	PES	EI	ES	EIS	Wetland Importance
(1)	Central valley-bottom wetland system (Wetlands 1 and 2)	Wetland (incl. pans)	E	Moderate	Moderate	Moderate	Moderate
(2)	Southern seep (south-east of the WWTW)	Wetland (incl. pans)	E	Moderate	Moderate	Moderate	Moderate
(3)	Jan Dissels River and floodplain wetland	River / Natural channel	D	High	Very high	Very high	Very high
(4)	Olifants River and floodplain wetland (below the confluence)	River / Natural channel	D	Moderate	Very high	Very high	Very high
(5)	Historic non-perennial tributaries of the Jan Dissels River	River / Natural channel	E/F	Not assessed	Not assessed	Not assessed	Not assessed

DETAILED PROJECT SPECIFICATIONS:

Please refer to the Aquatic Biodiversity Impact Assessment Addendum:

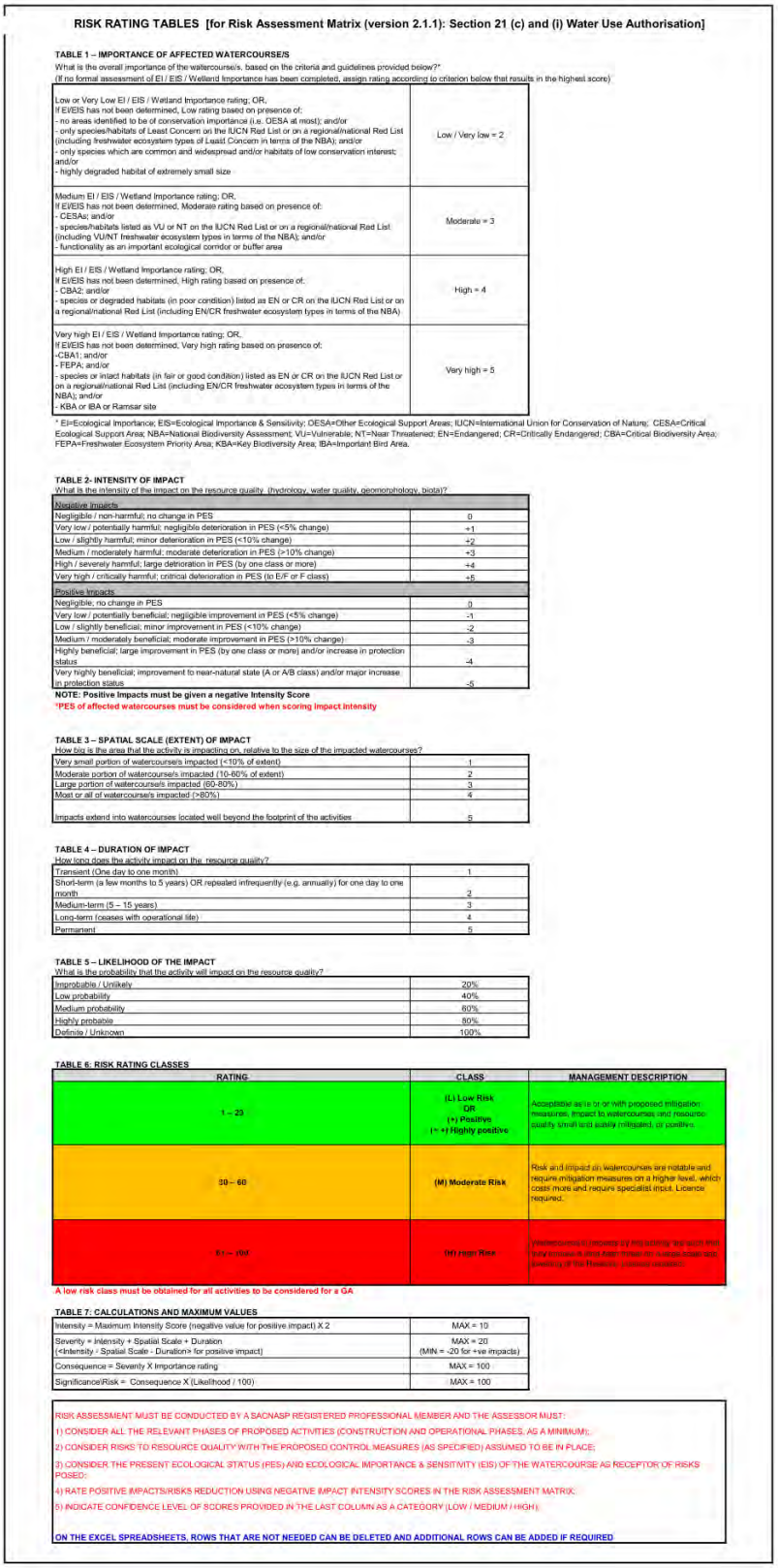
Van Zyl, K. and Morton, R. 2026. Aquatic Biodiversity Impact Assessment Addendum: Stormwater Management and WWTW Expansion, Clanwilliam Housing Development, Remainder Erf 279, Clanwilliam V1.0. Delta Ecology. RSA.

Activities: (1) construction of stormwater infrastructure (21 headwalls, four attenuation ponds and the piped connection within the central valley-bottom wetland system) and wetland rehabilitation; (2) refurbishment and expansion of the Clanwilliam WWTW (new 1.5 Ml/day module; upgraded works to treat at least 3.6 Ml/day at peak); (3) operation of the stormwater system; (4) operation of the upgraded WWTW and discharge of treated effluent through the southern seep to the Jan Dissels River; (5) irrigation of the golf course with treated effluent.

Control measures assumed in the scoring (Section 6 of the addendum): post-development peak flows attenuated to pre-development levels; stormwater treatment train, including the stormwater from the existing informal settlement; outlets and ponds outside the wetland with energy dissipation and diffuse discharge; no-go areas, dry-season construction, sediment and spill control; no bypass of untreated sewage during tie-ins; effluent treated to the Special Limit Values (GN 665 of 2013) with a specialist process engineer, works manager and operational support; retention of the southern seep reed bed as a polishing wetland; water balance, storage and irrigation management plan; implementation of the Wetland Rehabilitation and Management Plan; monitoring plan including effluent, water quality, SASS5 and fish.

Watercourse importance: central valley-bottom wetland system and southern seep from WET-EcoServices and the wetland EIS (Moderate); Jan Dissels and Olifants rivers from the DWS (2014) desktop PES/EIS (integrated EIS Very High).

Figure A-1: RAM – potentially affected watercourses and project specifications.



RISK RATING TABLES [for Risk Assessment Matrix (version 2.1.1): Section 21 (c) and (i) Water Use Authorisation]

TABLE 1 – IMPORTANCE OF AFFECTED WATERCOURSE/S

What is the overall importance of the watercourse/s, based on the criteria and guidelines provided below?*
(If no formal assessment of EI / EIS / Wetland Importance has been completed, assign rating according to criterion below that results in the highest score)

Low or Very Low EI / EIS / Wetland Importance rating; OR, If EI/EIS has not been determined, Low rating based on presence of: - no areas identified to be of conservation importance (i.e. CESA at most); and/or - only species/habitats of Least Concern on the IUCN Red List or on a regional/national Red List (including freshwater ecosystem types of Least Concern in terms of the NBA); and/or - only species which are common and widespread and/or habitats of low conservation interest; and/or - highly degraded habitat of extremely small size	Low / Very low = 2
Medium EI / EIS / Wetland Importance rating; OR, If EI/EIS has not been determined, Moderate rating based on presence of: - CESAs; and/or - species/habitats listed as VU or NT on the IUCN Red List or on a regional/national Red List (including VU/NT freshwater ecosystem types in terms of the NBA); and/or - functionality as an important ecological corridor or buffer area	Moderate = 3
High EI / EIS / Wetland Importance rating; OR, If EI/EIS has not been determined, High rating based on presence of: - CBA2; and/or - species or degraded habitats (in poor condition) listed as EN or CR on the IUCN Red List or on a regional/national Red List (including EN/CR freshwater ecosystem types in terms of the NBA)	High = 4
Very high EI / EIS / Wetland Importance rating; OR, If EI/EIS has not been determined, Very high rating based on presence of: -CBA1; and/or - FEPA; and/or - species or intact habitats (in fair or good condition) listed as EN or CR on the IUCN Red List or on a regional/national Red List (including EN/CR freshwater ecosystem types in terms of the NBA); and/or - KBA or IBA or Ramsar site	Very high = 5

* EI=Ecological Importance; EIS=Ecological Importance & Sensitivity; OESA=Other Ecological Support Areas; IUCN=International Union for Conservation of Nature; CESA=Critical Ecological Support Area; NBA=National Biodiversity Assessment; VU=Vulnerable; NT=Near Threatened; EN=Endangered; CR=Critically Endangered; CBA=Critical Biodiversity Area; FEPA=Freshwater Ecosystem Priority Area; KBA=Key Biodiversity Area; IBA=Important Bird Area.

TABLE 2- INTENSITY OF IMPACT

What is the intensity of the impact on the resource quality (hydrology, water quality, geomorphology, biota)?

Negative impacts	
Negligible / non-harmful; no change in PES	0
Very low / potentially harmful; negligible deterioration in PES (<5% change)	+1
Low / slightly harmful; minor deterioration in PES (<10% change)	+2
Medium / moderately harmful; moderate deterioration in PES (>10% change)	+3
High / severely harmful; large detrioration in PES (by one class or more)	+4
Very high / critically harmful; critical deterioration in PES (to E/F or F class)	+5
Positive impacts	
Negligible; no change in PES	0
Very low / potentially beneficial; negligible improvement in PES (<5% change)	-1
Low / slightly beneficial; minor improvement in PES (<10% change)	-2
Medium / moderately beneficial; moderate improvement in PES (>10% change)	-3
Highly beneficial; large improvement in PES (by one class or more) and/or increase in protection status	-4
Very highly beneficial; improvement to near-natural state (A or A/B class) and/or major increase in protection status	-5

NOTE: Positive impacts must be given a negative Intensity Score
***PES of affected watercourses must be considered when scoring impact intensity**

TABLE 3 – SPATIAL SCALE (EXTENT) OF IMPACT

How big is the area that the activity is impacting on, relative to the size of the impacted watercourses?

Very small portion of watercourse/s impacted (<10% of extent)	1
Moderate portion of watercourse/s impacted (10-60% of extent)	2
Large portion of watercourse/s impacted (60-80%)	3
Most or all of watercourse/s impacted (>80%)	4
Impacts extend into watercourses located well beyond the footprint of the activities	5

TABLE 4 – DURATION OF IMPACT

How long does the activity impact on the resource quality?

Transient (One day to one month)	1
Short-term (a few months to 5 years) OR repeated infrequently (e.g. annually) for one day to one month	2
Medium-term (5 – 15 years)	3
Long-term (ceases with operational life)	4
Permanent	5

TABLE 5 – LIKELIHOOD OF THE IMPACT

What is the probability that the activity will impact on the resource quality?

Improbable / Unlikely	20%
Low probability	40%
Medium probability	60%
Highly probable	80%
Definite / Unknown	100%

TABLE 6: RISK RATING CLASSES

RATING	CLASS	MANAGEMENT DESCRIPTION
1 – 29	(L) Low Risk OR (+) Positive (= +) Highly positive	Acceptable as is or with proposed mitigation measures, impact to watercourses and resource quality small and easily mitigated, or positive.
30 – 60	(M) Moderate Risk	Risk and impact on watercourses are notable and require mitigation measures on a higher level, which costs more and require specialist input. Licence required.
61 – 100	(H) High Risk	Watercourses or resource by the activity are such that they cannot be adequately protected or mitigated, or the activity should not be allowed to occur.

A low risk class must be obtained for all activities to be considered for a GA

TABLE 7: CALCULATIONS AND MAXIMUM VALUES

Intensity = Maximum Intensity Score (negative value for positive impact) X 2	MAX = 10
Severity = Intensity + Spatial Scale + Duration (+Intensity / Spatial Scale / Duration= for positive impact)	MAX = 20 (MIN = -20 for +ve impacts)
Consequence = Severity X Importance rating	MAX = 100
Significance/Risk = Consequence X (Likelihood / 100)	MAX = 100

RISK ASSESSMENT MUST BE CONDUCTED BY A SACNASP REGISTERED PROFESSIONAL MEMBER AND THE ASSESSOR MUST:

1) CONSIDER ALL THE RELEVANT PHASES OF PROPOSED ACTIVITIES (CONSTRUCTION AND OPERATIONAL PHASES, AS A MINIMUM);

2) CONSIDER RISKS TO RESOURCE QUALITY WITH THE PROPOSED CONTROL MEASURES (AS SPECIFIED) ASSUMED TO BE IN PLACE;

3) CONSIDER THE PRESENT ECOLOGICAL STATUS (PES) AND ECOLOGICAL IMPORTANCE & SENSITIVITY (EIS) OF THE WATERCOURSE AS RECEPTOR OF RISKS POSED;

4) RATE POSITIVE IMPACTS/RISKS REDUCTION USING NEGATIVE IMPACT INTENSITY SCORES IN THE RISK ASSESSMENT MATRIX;

5) INDICATE CONFIDENCE LEVEL OF SCORES PROVIDED IN THE LAST COLUMN AS A CATEGORY (LOW / MEDIUM / HIGH).

ON THE EXCEL SPREADSHEETS, ROWS THAT ARE NOT NEEDED CAN BE DELETED AND ADDITIONAL ROWS CAN BE ADDED IF REQUIRED

Figure A-2: RAM – risk rating tables.

PROJECT: Clanwilliam Housing Development and WWTW Expansion, Remainder Erf 275, Clanwilliam

RISK ASSESSMENT MATRIX for Section 21 (c) and (i) Water Use activities - Version 2.1.1

Name of Assessor: Kotsiantis Jim (Dr) Signature: (E)(1)(E)

SACNASP Registration Number: (Pr. Nat. Sci. Reg. No.: 117027) (Ecological)

Date of assessment: 03-Oct-25

Phase	Activity	Impact	Planning phase assessment		Intensity of Impact (without mitigation) Severity						Overall Intensity (max = 10)	Spatial scale (max = 5)	Duration (max = 5)	Severity (max = 25)	Importance (max = 5)	Consequence (max = 100)	Likelihood (Probability of Impact)	Significance (max = 100)	Risk Rating	Confidence level
			Criteria Watercourse Importance	PES	Fauna	Flora (Ruggedness)	Vegetation	Groundwater	Aquatic Habitat (Drivers) Water Quality	Hydrology										
CONSTRUCTION	<1> Construction of stormwater infrastructure (Headwalls, outlets, dissipaters, rip-rap, and the tie-in with the existing stormwater system and wetland headwaters)	<1> Direct loss of wetland habitat (Impact 1)	Moderate	E	1	1	2	2	1	1	4	2	2	8	3	24	100%	24	Low	Medium
		<2> Exposure and sedimentation of the wetland (Impact 2)	Moderate	E	1	1	2	2	1	1	4	2	2	8	3	24	100%	24	Low	Medium
	<2> Establishment and maintenance of the WWTW (Including the re-lining of river mouth)	<1> Direct loss of Cape Flats Dune Strandveld habitat (Impact 1)	Very High	D	1	1	1	0	0	0	2	1	2	6	3	16	40%	16	Low	Medium
		<2> Direct loss of Cape Flats Dune Strandveld habitat (Impact 2)	Very High	D	1	1	1	0	0	0	2	1	2	6	3	16	40%	16	Low	Medium
		<3> Direct loss of Cape Flats Dune Strandveld habitat (Impact 3)	Very High	D	1	1	1	0	0	0	2	1	2	6	3	16	40%	16	Low	Medium
OPERATION	<1> Operation of the stormwater network, discharges of treated and attenuated stormwater (Including the re-lining of river mouth) from the pump station/s and stormwater network	Cape Flats Dune Strandveld habitat loss/degradation (Impact 4)	Moderate	E	2	1	2	1	1	1	4	2	2	8	3	24	100%	24	Low	Medium
		<2> Erosion and sedimentation of the wetland (Impact 5)	Moderate	E	1	1	2	2	1	1	4	2	2	8	3	24	100%	24	Low	Medium
		<3> Water quality impairment from stormwater (Impact 6)	Moderate	E	1	1	2	2	1	1	4	2	2	8	3	24	100%	24	Low	Medium
		<4> Water quality impairment of the Jan Dissels River from the Clanwilliam WWTW (Impact 7)	Very High	D	1	1	2	2	1	1	4	2	2	8	3	24	100%	24	Low	Medium
	<2> Operation of the upgraded and expanded WWTW (Including the re-lining of river mouth)	<1> Treated effluent quality in the Jan Dissels River (Impact 1)	Very High	D	1	1	2	2	1	1	4	2	2	8	3	24	100%	24	Low	Medium
		<2> Altered flow regime of the Jan Dissels River from the Housing development's effluent and stormwater (Impact 2)	Very High	D	1	1	2	2	1	1	4	2	2	8	3	24	100%	24	Low	Medium
		<3> Altered flow regime of the Jan Dissels River (Impact 3)	Very High	D	1	1	2	2	1	1	4	2	2	8	3	24	100%	24	Low	Medium
		<4> Treated effluent quality in the Jan Dissels River (Impact 4)	Moderate	C	1	1	2	2	1	1	4	2	2	8	3	24	100%	24	Low	Medium
		<5> Altered flow regime of the Olifants River downstream of the confluence (Impact 5)	Very High	D	1	1	2	2	1	1	4	2	2	8	3	24	100%	24	Low	Medium
	<3> Irrigation of the golf course with treated effluent	<1> Nutrients and loading of the central Olifants River system (Impact 1)	Moderate	C	1	1	2	2	1	1	4	2	2	8	3	24	100%	24	Low	Medium
		<2> Salinisation and loading of the soil (Impact 2)	Moderate	C	1	1	2	2	1	1	4	2	2	8	3	24	100%	24	Low	Medium

Figure A-3: RAM – risk assessment (rotated).

PROJECT: Clanwilliam Housing Development and WWTW Expansion, Remainder Erf

RISK ASSESSMENT MATRIX for Section 21 (c) and (i) Water Use activities - Version 2.1.1

Name of Assessor: Kimberley van Zyl
SACNASP Registration Number: Pr. Nat. Sci. Reg. No.117097 (Ecological)
Date of assessment: 13-Oct-26

Phase	Activity	Impact	Significance (max = 100)	Risk Rating	Confidence level
CONSTRUCTION	<1> Construction of stormwater infrastructure (headwalls, outlets, attenuation ponds and the piped connection) in and next to the central valley-bottom wetland system, and wetland rehabilitation works.	<1a> Disturbance of wetland habitat (IA Impact 1)	14.4	L	High
		<1b> Erosion and sedimentation of the wetland (IA Impact 2)	14.4	L	High
		<1c> Sediment carried downstream to the Jan Dissels River (IA Impact 2)	10	L	Medium
	<2> Refurbishment and expansion of the WWTW, including tie-ins of new units	<2a> Water quality impairment from temporary deterioration or bypass during tie-ins (IA Impact 3)	14.4	L	Medium
		<2b> Water quality impairment from temporary deterioration or bypass during tie-ins (IA Impact 3)	16	L	Medium
OPERATION	<3> Operation of the stormwater system discharge of treated and attenuated stormwater from the development and the existing informal settlement into the central valley-bottom wetland system	<3a> Altered hydrological regime of the wetland (IA Impact 4)	24	L	Medium
		<3b> Erosion at stormwater outlets (IA Impact 5)	16.2	L	High
		<3c> Water quality impairment from urban stormwater (IA Impact 6)	24	L	Medium
		<3d> Water quality impairment of the Jan Dissels River from urban stormwater (IA Impact 6)	21	L	Medium
	<4> Operation of the upgraded and expanded WWTW: discharge of treated effluent through the southern seep to the Jan Dissels River	<4a> Treated effluent quality in the Jan Dissels River (IA Impact 7)	40	M	Medium
		<4b> Altered flow regime of the Jan Dissels River from the housing development's effluent, about 640 m³/day (IA Impact 8a)	24	L	Medium
		<4c> Altered flow regime of the Jan Dissels River from the full 1.5 Mℓ/day expansion (IA Impact 8b)	40	M	Medium
		<4d> Altered hydrological regime and extent of the southern seep (IA Impact 11)	28.4	L	Medium
		<4e> Treated effluent quality in the southern seep (IA Impact 13)	24	L	Medium
		<4f> Water quality impairment in the Olifants River downstream of the confluence (IA Impact 10)	21	L	Medium
		<4g> Altered flow regime of the Olifants River downstream of the confluence (IA Impact 11)	14	L	Medium
	<5> Irrigation of the golf course with treated effluent	<5a> Nutrient and salt loading of the central valley-bottom wetland system (IA Impact 9)	16	L	Medium
		<5b> Nutrient and salt loading of the southern seep (IA Impact 9)	18	L	Medium

Figure A-4: RAM – summary of the risk assessment.

Annexure B: Methodology

Riparian Area Delineation

Riparian areas were identified using the method described in the DWAF, (2008) Updated Manual for the Identification and Delineation of Wetlands and Riparian Areas. This method is the accepted best practice method for identifying and delineating riparian areas in South Africa and its use is required by GN 509. The method makes use of four key field indicators (refer to **Box 1**):

Four indicators of riparian areas as described in DWAF (2008)

1. The **position in the landscape** – riparian areas are only likely to develop on valley bottom landscape units.
2. The **soil form** – Riparian areas are often (but not always) associated with alluvial soils and recently deposited material.
3. **Topography** associated with riparian areas – riparian areas may have clearly identifiable banks associated with alluvial deposited material adjacent to the active channel.
4. The presence of **aquatic vegetation communities.**

The identification of riparian areas relies heavily on vegetative indicators. Using vegetation, the outer boundary of a riparian area can be defined as the point where a distinctive change occurs in the:

- species composition relative to the adjacent terrestrial area; and
- physical structure, such as vigour or robustness of growth forms of species like that of adjacent terrestrial areas. Growth form refers to the health, compactness, crowding, size, structure and/or numbers of individual plants.

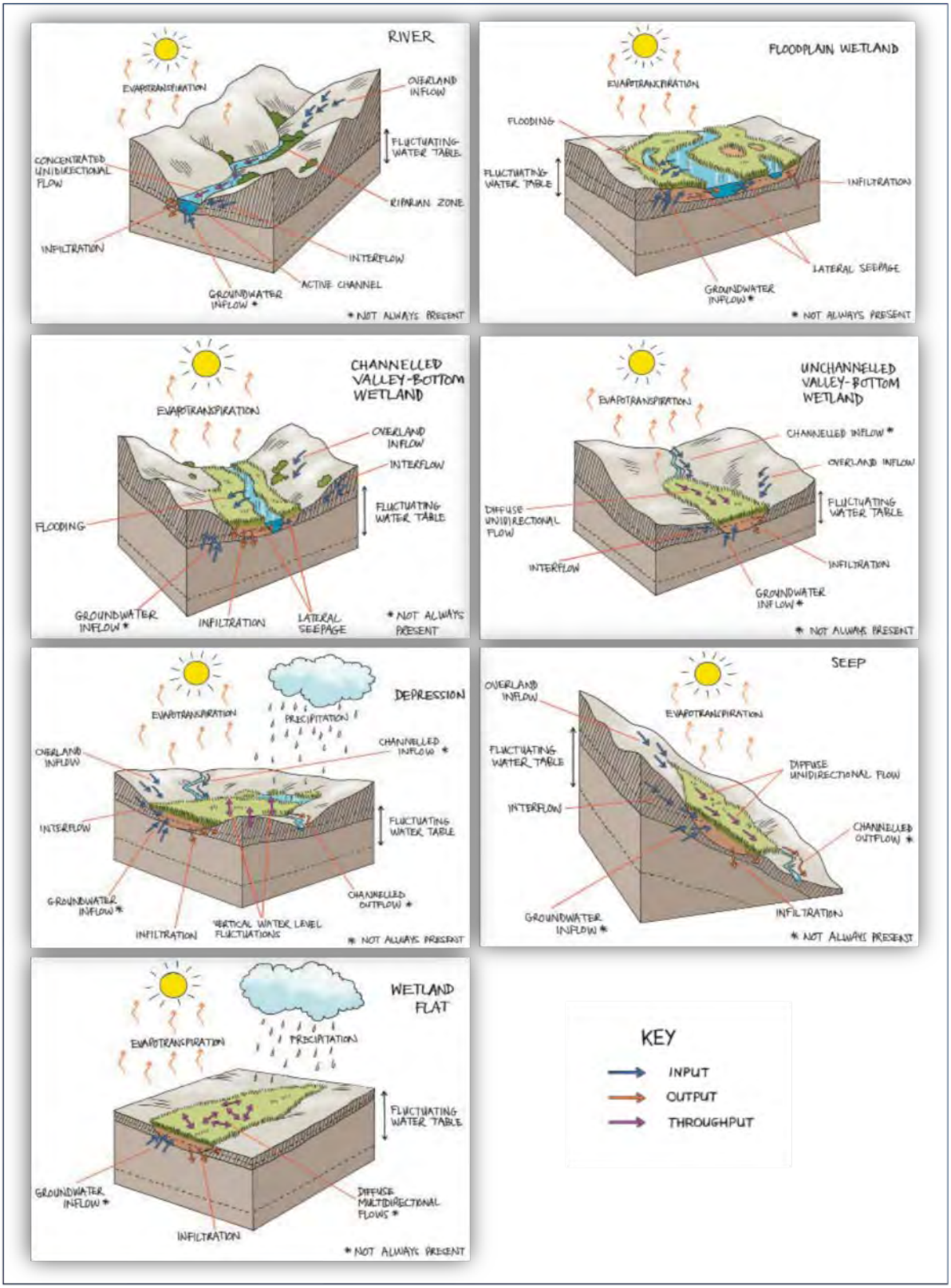
In addition to indicators of structural differences in vegetation, indicator species themselves can be used to denote riparian areas. Riparian plant species classification categories are as follows:

- Obligate riparian species occur almost exclusively in the riparian zone (> 90% probability)

  Preferential riparian species are preferentially, but not exclusively, found in the riparian zone (>75% probability). Preferential riparian species may harden to drought conditions but will always indicate sites with increased moisture availability.

Wetland Classification

The Ollis *et al* (2013) Classification System for Wetlands and Other Aquatic Ecosystems in South Africa, as used in this assessment, is a tiered structured classification system that provides a uniform description of wetland types based on their hydrogeomorphic characteristics:



Wetland Present Ecological State

The Present Ecological State (PES) of the wetlands was assessed with WET-Health Version 2 (Macfarlane et al., 2020), which rates the deviation of the wetland's hydrology, geomorphology, water quality and vegetation from their natural reference condition.

Water Quality Sampling

Grab samples were collected from the Jan Dissels River upstream and downstream of the WWTW effluent release on 29 September 2026, in bottles supplied by the laboratory, kept cool and delivered to NviroTek Wynland Laboratories, Wellington (received on 30 September and 1 October 2026). E. coli was enumerated as colony-forming units per 100 ml (method W106). Chemical parameters (pH, EC, COD, suspended solids, nutrients, major ions and metals) were analysed by NviroTek (report S26/5257, preliminary, 7 October 2026). Un-ionised ammonia was estimated from total ammonia using Table 1 of DWAF (1996a).

Habitat Integrity Assessment

The Index of Habitat Integrity (IHI) assessment is a tool used to assess the habitat integrity of a river based on the intensity and extent of anthropogenic disturbances that impact both the instream and riparian habitat. The assessment of habitat integrity is based on an interpretation of the deviation from the reference condition (Kleynhans *et al.*, 2008). The disturbances assessed include abiotic factors such as water abstraction, weirs, dams, pollution and the dumping or rubble and biotic factors such as the presence of alien plants and aquatic animals which modify habitat (Kleynhans, 1996). These changes are all related and interpreted in terms of modification of the drivers of the system, namely hydrology, geomorphology, and physico-chemical conditions and how these changes would impact on the natural riverine habitats. The severity of each of these impacts is assessed, using scores as a measure of impact (**Table A**). Descriptions of each criterion are provided to assist with the assessment (**Table B**).

Table A: Scoring procedures used to determine the Index of Habitat Integrity.

IMPACT CLASS	DESCRIPTION	SCORE
None	No discernible impact or the modification is located in such a way that it has no impact on habitat quality, diversity, size and variability.	0
Small	The modification is limited to very few localities and the impact on habitat quality, diversity, size, and variability is limited.	1 – 5
Moderate	The modification is present at a small number of localities and the impact on habitat quality, diversity, size, and variability are fairly limited.	6 - 10
Large	The modification is generally present with a clearly detrimental impact on habitat quality, diversity, size, and variability. Large areas are, however, not affected.	11 -15
Serious	The modification is frequently present and the habitat quality, diversity, size and variability in almost the whole of the defined area affected. Only small areas are not influenced.	16 – 20
Critical	The modification is present overall with a high intensity. The habitat quality, diversity, size and variability in almost the whole of the defined section are influenced detrimentally.	21 – 25

Table B: Descriptions of criteria used in the IHI assessments (Kleynhans, 1996).

CRITERION	DESCRIPTION
Water abstraction	Direct abstraction from within the specified river/river reach as well as upstream (including tributaries) must be considered (excludes indirect abstraction by for example exotic vegetation). The presence of any of the following can be used as an indication of abstraction: cultivated lands, water pumps, canals, pipelines, cities, towns, settlements, mines, impoundments, weirs, industries. Water abstraction has a direct impact on habitat type, abundance, and size; is implicated in flow, bed, channel and water quality characteristics; and riparian vegetation may be influenced by a decrease in water quantity.
Extent of inundation	Destruction of instream habitat (e.g. riffle, rapid) and riparian zone habitat through submerging with water by, for example, construction of an in-channel impoundment such as a dam or weir. Leads to a reduction in habitat available to aquatic fauna and may obstruct movement of aquatic fauna; influences water quality and sediment transport.
Water quality	The following aspects should be considered: untreated sewage, urban and industrial runoff, agricultural runoff, mining effluent, effects of impoundments. Ranking may be based on direct measurements or indirectly via observation of agricultural activities, human settlements, and industrial activities in the area. Water quality is aggravated by a decrease in the volume of water during low or no flow conditions.
Flow modification	This relates to the consequence of abstraction or regulation by impoundments. Changes in temporal and spatial characteristics of flow such as an increase in duration of low flow season can have an impact on habitat attributes, resulting in low availability of certain habitat types or water at the start of the breeding, flowering, or growing season.
Bed modification	This is regarded as the result of increased input of sediment from the catchment or a decrease in the ability of the river to transport sediment. The effect is a reduction in the quality of habitat for biota. Indirect indications of sedimentation are stream bank and catchment erosion. Purposeful alteration of the stream bed, e.g. the removal of rapids for navigation is also included. Extensive algal growth is also considered to be bed modification.
Channel modification	This may be the result of a change in flow which alters channel characteristics causing a change in instream and riparian habitat. Purposeful channel modification to improve drainage is also included.
Presence of exotic aquatic fauna	The disturbance of the stream bottom during exotic fish feeding may influence, for example, the water quality and lead to increased turbidity. This leads to a change in habitat quality.
Presence of exotic macrophytes	Exotic macrophytes may alter habitat by obstruction of flow and may influence water quality. Consider the extent of infestation over instream area by exotic macrophytes, the species involved and its invasive abilities.
Solid Waste disposal	The amount and type of waste present in and on the banks of a river (e.g. litter, building rubble) is an obvious indicator of external influences on stream and a general indication of the misuse and mismanagement of the river.
Decrease of indigenous vegetation from the riparian zone	This refers to physical removal of indigenous vegetation for farming, firewood, and overgrazing. Impairment of the riparian buffer zone may lead to movement of sediment and other catchment runoff products (e.g. nutrients) into the river.
Exotic vegetation encroachment	This excludes natural vegetation due to vigorous growth, causing bank instability and decreasing the buffering function of the riparian zone. Encroachment of exotic vegetation leads to changes in the quality and proportion of natural

CRITERION	DESCRIPTION
	allochthonous organic matter input and diversity of the riparian zone habitat is reduced.
Bank erosion	A decrease in bank stability will cause sedimentation and possible collapse of the riverbank resulting in a loss or modification of both instream and riparian habitats. Increased erosion can be the result of natural vegetation removal, overgrazing or encroachment of exotic vegetation.

The score that has been allocated to an impact is then moderated by a weighting system, devised by Kleynhans (1996). Assignment of weights is based on the perceived relative threat of the impact to the habitat integrity of a riverine ecosystem. The total score for each impact is equal to the assigned score multiplied by the weight of that impact (**Table C**).

Table C: Weights assigned to each criterion

INSTREAM CRITERION	WGT	RIPARIAN ZONE CRITERION	WGT
Water abstraction	14	Water abstraction	13
Extent of inundation	10	Extent of inundation	11
Water quality	14	Water quality	13
Flow modification	7	Flow modification	7
Bed modification	13	Channel modification	12
Channel modification	13	Indigenous vegetation removal	13
Presence of exotic macrophytes	9	Exotic vegetation encroachment	12
Presence of exotic fauna	8	Bank erosion	14
Solid waste disposal	6		

Based on the relative weights of the criteria, the impacts of each criterion are estimated as follows:

Rating for the criterion /maximum value (25) x the weight (percent).

The estimated impacts of all criteria calculated in this way are summed, expressed as a percentage, and subtracted from 100 to arrive at a present status score for the instream and riparian components, respectively. The Index of Habitat Integrity scores (%) for the instream and riparian zone components are then used to place these two components into a specific class. These classes are indicated in **Table D**. The assessment method in determining the severity of modifications to habitat integrity is a largely field-based site assessment, supplemented with information from aerial photographs (google earth images).

Table D: IHI classes and their description

CLASS	DESCRIPTION	SCORE (%)
A	Unmodified, natural.	90 – 100
B	Largely natural with few modifications. A small change in natural habitats and biota may have taken place, but the assumption is that ecosystem functioning is essentially unchanged.	80 - 89
C	Moderately modified. A loss or change in natural habitat and biota has occurred, but basic ecosystem functioning appears predominately unchanged.	60 – 79

D	Largely modified. A loss of natural habitat and biota and a reduction in basic ecosystem functioning is assumed to have occurred.	40 – 59
E	Seriously modified. The loss of natural habitat, biota and ecosystem functioning is extensive.	20 – 39
F	Modifications have reached a critical level and there has been an almost complete loss of natural habitat and biota. In the worst cases, the basic ecosystem functioning has been destroyed.	0 - 19

Ecosystem Service Assessment

WET-EcoServices Version 2 (Kotze *et al.*, 2021) is a structured and rapid field-based evaluation tool designed to assess the wetlands and riparian areas ecosystem services based on their Hydrogeomorphic (HGM) unit. The tool accounts for 16 ecosystem services which are derived from regulating (e.g., flood attenuation), provisioning (e.g., water supply), supporting (e.g., biodiversity maintenance), and cultural (e.g., tourism and recreation) services. The tool evaluates the scale of ecosystem services supplied (in terms of a score out of 4 per service) relative to other wetlands and riparian areas and furthermore compares the scale of service supply to the demand for each service. The scores are divided into seven categories as per **Table E**. The tool offers two levels of assessment, namely Level 1 (a rapid desktop assessment) and Level 2 (a detailed field-based indicator assessment). Level 1 is designed for conducting rapid desktop assessments of many wetlands and riparian areas across provincial and national scales. Ratings are assigned based on the Hydrogeomorphic unit of the wetland. Level 2 is designed for conducting robust in-field assessments of ecosystem services for respective wetland types and/or riparian areas. The level 2 Ecosystem Service assessment was applied to a riparian area in this case.

Table E: Ecosystem Services Importance Categories Scores as defined in WET-EcoServices Version 2 (Kotze *et al.* 2020).

Importance Category		Description
Very Low	0-0.79	The importance of services supplied is very low relative to that supplied by other wetlands.
Low	0.8 – 1.29	The importance of services supplied is low relative to that supplied by other wetlands.
Moderately-Low	1.3 – 1.69	The importance of services supplied is moderately-low relative to that supplied by other wetlands.
Moderate	1.7 – 2.29	The importance of services supplied is moderate relative to that supplied by other wetlands.
Moderately-High	2.3 – 2.69	The importance of services supplied is moderately-high relative to that supplied by other wetlands.
High	2.7 – 3.19	The importance of services supplied is high relative to that supplied by other wetlands.
Very High	3.2 - 4.0	The importance of services supplied is very high relative to that supplied by other wetlands.

Ecological Importance and Sensitivity Assessment

The Ecological Importance and Sensitivity (EIS) was determined for the watercourse using an adapted version of the DWAF (1999) River EIS methodology. In this case, it has been adapted for application to "Ecological importance" of a water resource is an expression of its importance to the maintenance of ecological diversity and functioning on local and wider scales. "Ecological sensitivity" refers to the system's ability to resist disturbance and its capability to recover from disturbance once it has occurred (DWAF, 1999). A series of determinants for EIS are assessed on a scale of 0 to 4, where 0 indicates "None" and 4 indicates "Very high importance" and the median of the determinants indicates the EIS category for the watercourse (**Table F**). Weighting of the relative importance of the various determinants of ecological importance and sensitivity was not proposed. However, the relative confidence of each rating should be estimated based on a scale of four categories where 1 indicated "Marginal/low confidence" and 4 indicated "Very High confidence". The median score for the biotic and habitat determinants can be interpreted and translated into an EMC (**Table F**), however for the purposes of this assessment, the Recommended Ecological Category (REC) methodology as described in Rountree et al., (2013) was utilized.

Table F: Ecological Importance and Sensitivity Categories (DWAF, 1999).

EIS CATEGORY	RANGE OF MEDIAN	RECOMMENDED ECOLOGICAL MANAGEMENT CLASS
Very high Watercourses that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these watercourses is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of other major rivers.	>3 and <=4	A
High Watercourses that are considered to be ecologically important and sensitive. The biodiversity of these watercourses may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of other major rivers.	>2 and <=3	B
Moderate Watercourses that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these watercourses is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of other major rivers.	>1 and <=2	C
Low/marginal Watercourses that are not ecologically important and sensitive at any scale. The biodiversity of these watercourses is ubiquitous and not sensitive to flow and habitat modifications. They play	>0 and <=1	D

an insignificant role in moderating the quantity and quality of water of other major rivers.		

Recommended Ecological Category

The method for determining the Recommended Ecological Category (REC) for water resources is described in Rountree *et al*. (2013). The objective of the REC is to define the management objective for wetlands and does so in accordance with the following rules:

- A wetland within PES Category A (unmodified) cannot be rehabilitated. The management objective will therefore always be to maintain the existing PES Category.
- A wetland within PES Category B, C or D with a "Low-marginal" or "Moderate" EIS score must also be maintained in the pre-development PES category.
- A wetland within PES Category B, C or D with a "High" or "Very High" EIS score must, where practically possible, be rehabilitated to a PES category that is one higher than the pre-development category. E.g. a wetland with a pre-development PES score of C and a "High" EIS score must be rehabilitated to a PES category B. Where this is not practically possible, maintenance of the pre-development PES category will be the management objective.
- PES Categories E or F are considered unsuitable and always require rehabilitation to a PES Category D.

IMPACT ASSESSMENT METHODOLOGY

Impact assessment methodologies are based on qualitative ratings of the various factors and represent a standardised method for presenting a substantiated specialist opinion regarding the significance of a particular class of impact. Delta Ecology has developed a rapid numerical impact assessment methodology, applied in this report, that incorporates a range of factors commonly assessed to which numerical values from 1 to 5 are assigned to each rating category. Six primary factors are used to determine Consequence, and two primary factors are used to determine Probability. These two secondary factors are used to determine Impact Significance for each identified impact. Consequence, Probability, and Impact Significance are determined by a set of formulae which incorporate weightings for each primary and secondary factor.

The weightings for each factor were determined by application of the formulae to over 50 pre-existing ecological impact assessments. These assessments employed other methodologies and were accepted by the relevant environmental authorities. These assessments were primarily from reports drafted by Delta Ecology staff during previous employment but also included unrelated ecological impact assessments freely available on the internet. The weighting system has therefore been derived as a means of real-world formula calibration rather than by logic alone. The final methodology achieves impact significance ratings that are consistently in line with industry standards.

Key elements of the approach include a detailed description of the nature of the impact and of the proposed mitigation measures, assessment of each factor for both the "with mitigation" and "without mitigation" scenarios and includes the provision of a rationale for each rating where appropriate. The resulting impact significance ratings may be adjusted, if necessary, in accordance with specialist opinion, given adequate motivation for the deviation from the standard methodology.

The various factors, formulae and weightings are provided in the table below:

Scoring of impacts			
Factor	**Weighting**	**Score**	**Description/Rating**
Consequence	**8**		
Intensity	4	1	Very Low / Non-harmful
		2	Low / Slightly Harmful
		3	Medium / Harmful
		4	High / Very Harmful
		5	Very High / Disastrous
Duration	1	1	Up to 1 month
		2	1 month to 1 year
		3	One year to 5 years
		4	5 to 20 years
		5	Beyond 20 years / Permanent
Spatial scale/extent	3	1	Limited to project site
		2	Limited to local catchment
		3	Multiple local catchments
		4	Limited to quaternary catchment
		5	Regional, National, International
Reversibility	1	1	Passive restoration / High likelihood of success
		2	Low-cost rehabilitation / Moderately high likelihood of success
		3	Moderate cost / Moderate likelihood of success
		4	High cost / Low likelihood of success
		5	Very high cost / Very low likelihood of success
Loss of irreplaceable resources	1	1	None
		2	Low
		3	Medium
		4	High
		5	Very High
Cumulative Impact	1	1	Very Low
		2	Low
		3	Medium
		4	High
		5	Very High
Probability	**2**		
Frequency of the activity	1	1	Once off activity / less than once in 20 years
		2	5 to 20 years
		3	1 to 5 years
		4	Monthly to annually
		5	Weekly to Monthly
Likelihood of the Incident / Impact occurring	1	1	Highly unlikely
		2	Unlikely
		3	Possible
		4	Likely
		5	Definite
Consequence = (Intensity x 4) + Duration + (Extent x 3) + Reversibility + Loss of Irreplaceable Resources + Cumulative Impact) / 11			
Probability = (Frequency + Probability) / 2 OR = 5 where likelihood is definite			

Impact Significance = (Consequence x 8) + (Likelihood x 2) / 10	
Impact Significance Categories	
0 - 1.5	Very Low
1.6 - 2.5	Low
2.6 - 3.5	Medium
3.6 - 4.5	High
4.5 and above	Very High

Annexure C: Detailed Impact Ratings

Table C-1: Assessment results for Impact 1.

Impact 1: Disturbance of wetland habitat during construction of stormwater infrastructure				
	Impact Without Mitigation		Impact With Mitigation	
Consequence				
Intensity of Impact	3	Medium / Harmful	2	Low / Slightly Harmful
Duration of Impact	3	One year to 5 years	2	1 month to 1 year
Extent / spatial scale of impact	1	Limited to project site	1	Limited to project site
Reversibility	2	Low-cost rehabilitation / Moderately high likelihood of success	1	Passive restoration / High likelihood of success
Loss of irreplaceable resources	1	None	1	None
Cumulative Impact	3	Medium	2	Low
Probability				
Frequency of the Activity	4	Monthly to annually	4	Monthly to annually
Likelihood of the Incident / Impact occurring	5	Definite	4	Likely
Impact Significance				
Consequence	2.18	Low	1.54	Very Low
Probability	5.00	Very High	4.00	High
Impact Significance	2.74	Medium	2.03	Low

Table C-2: Assessment results for Impact 2.

Impact 2: Erosion and sedimentation of the wetlands during construction				
	Impact Without Mitigation		Impact With Mitigation	
Consequence				
Intensity of Impact	3	Medium / Harmful	2	Low / Slightly Harmful
Duration of Impact	3	One year to 5 years	2	1 month to 1 year

Extent / spatial scale of impact	2	Limited to local catchment	1	Limited to project site
Reversibility	3	Moderate cost / Moderate likelihood of success	2	Low-cost rehabilitation / Moderately high likelihood of success
Loss of irreplaceable resources	1	None	1	None
Cumulative Impact	3	Medium	2	Low
Probability				
Frequency of the Activity	4	Monthly to annually	4	Monthly to annually
Likelihood of the Incident / Impact occurring	4	Likely	2	Unlikely
Impact Significance				
Consequence	2.54	Low	1.63	Low
Probability	4.00	High	3.00	Medium
Impact Significance	2.83	Medium	1.90	Low

Table C-3: Assessment results for Impact 3.

Impact 3: Water quality impairment during construction, including the WWTW works				
	Impact Without Mitigation		**Impact With Mitigation**	
Consequence				
Intensity of Impact	4	High / Very Harmful	2	Low / Slightly Harmful
Duration of Impact	2	1 month to 1 year	1	Up to 1 month
Extent / spatial scale of impact	2	Limited to local catchment	2	Limited to local catchment
Reversibility	2	Low-cost rehabilitation / Moderately high likelihood of success	1	Passive restoration / High likelihood of success
Loss of irreplaceable resources	1	None	1	None
Cumulative Impact	4	High	3	Medium
Probability				
Frequency of the Activity	4	Monthly to annually	4	Monthly to annually

Likelihood of the Incident / Impact occurring	3	Possible	2	Unlikely
Impact Significance				
Consequence	2.81	Medium	1.81	Low
Probability	3.50	Medium	3.00	Medium
Impact Significance	2.95	Medium	2.05	Low

Table C-4: Assessment results for Impact 4.

Impact 4: Altered hydrological regime of Wetlands 1 and 2 from stormwater discharge				
	Impact Without Mitigation		**Impact With Mitigation**	
Consequence				
Intensity of Impact	3	Medium / Harmful	2	Low / Slightly Harmful
Duration of Impact	5	Beyond 20 years / Permanent	5	Beyond 20 years / Permanent
Extent / spatial scale of impact	1	Limited to project site	1	Limited to project site
Reversibility	4	High cost / Low likelihood of success	2	Low-cost rehabilitation / Moderately high likelihood of success
Loss of irreplaceable resources	2	Low	1	None
Cumulative Impact	4	High	3	Medium
Probability				
Frequency of the Activity	5	Weekly to Monthly	5	Weekly to Monthly
Likelihood of the Incident / Impact occurring	5	Definite	4	Likely
Impact Significance				
Consequence	2.72	Medium	2.00	Low
Probability	5.00	Very High	4.50	High
Impact Significance	3.18	Medium	2.50	Low

Table C-5: Assessment results for Impact 5.

Impact 5: Erosion at stormwater outlets				
	Impact Without Mitigation		Impact With Mitigation	
Consequence				
Intensity of Impact	3	Medium / Harmful	1	Very Low / Non-harmful
Duration of Impact	4	5 to 20 years	2	1 month to 1 year
Extent / spatial scale of impact	1	Limited to project site	1	Limited to project site
Reversibility	3	Moderate cost / Moderate likelihood of success	1	Passive restoration / High likelihood of success
Loss of irreplaceable resources	1	None	1	None
Cumulative Impact	3	Medium	2	Low
Probability				
Frequency of the Activity	5	Weekly to Monthly	5	Weekly to Monthly
Likelihood of the Incident / Impact occurring	4	Likely	2	Unlikely
Impact Significance				
Consequence	2.36	Low	1.18	Very Low
Probability	4.50	High	3.50	Medium
Impact Significance	2.79	Medium	1.64	Low

Table C-6: Assessment results for Impact 6.

Impact 6: Water quality impairment of the wetlands from urban stormwater				
	Impact Without Mitigation		Impact With Mitigation	
Consequence				
Intensity of Impact	3	Medium / Harmful	2	Low / Slightly Harmful
Duration of Impact	5	Beyond 20 years / Permanent	5	Beyond 20 years / Permanent
Extent / spatial scale of impact	2	Limited to local catchment	1	Limited to project site
Reversibility	3	Moderate cost / Moderate likelihood of success	2	Low-cost rehabilitation / Moderately high likelihood of success

Loss of irreplaceable resources	1	None	1	None
Cumulative Impact	4	High	3	Medium
Probability				
Frequency of the Activity	5	Weekly to Monthly	5	Weekly to Monthly
Likelihood of the Incident / Impact occurring	5	Definite	4	Likely
Impact Significance				
Consequence	2.81	Medium	2.00	Low
Probability	5.00	Very High	4.50	High
Impact Significance	3.25	Medium	2.50	Low

Table C-7: Assessment results for Impact 7.

Impact 7: Treated effluent quality in the Jan Dissels River				
	Impact Without Mitigation		**Impact With Mitigation**	
Consequence				
Intensity of Impact	4	High / Very Harmful	2	Low / Slightly Harmful
Duration of Impact	5	Beyond 20 years / Permanent	5	Beyond 20 years / Permanent
Extent / spatial scale of impact	3	Multiple local catchments	2	Limited to local catchment
Reversibility	3	Moderate cost / Moderate likelihood of success	2	Low-cost rehabilitation / Moderately high likelihood of success
Loss of irreplaceable resources	2	Low	1	None
Cumulative Impact	4	High	3	Medium
Probability				
Frequency of the Activity	5	Weekly to Monthly	5	Weekly to Monthly
Likelihood of the Incident / Impact occurring	5	Definite	3	Possible
Impact Significance				
Consequence	3.54	Medium	2.27	Low

Probability	5.00	Very High	4.00	High
Impact Significance	3.83	High	2.61	Medium

Table C-8a: Assessment results for Impact 8a.

Impact 8a: Altered flow regime of the Jan Dissels River from the housing development's effluent				
	Impact Without Mitigation		**Impact With Mitigation**	
Consequence				
Intensity of Impact	2	Low / Slightly Harmful	1	Very Low / Non-harmful
Duration of Impact	5	Beyond 20 years / Permanent	5	Beyond 20 years / Permanent
Extent / spatial scale of impact	2	Limited to local catchment	2	Limited to local catchment
Reversibility	3	Moderate cost / Moderate likelihood of success	2	Low-cost rehabilitation / Moderately high likelihood of success
Loss of irreplaceable resources	1	None	1	None
Cumulative Impact	4	High	3	Medium
Probability				
Frequency of the Activity	5	Weekly to Monthly	5	Weekly to Monthly
Likelihood of the Incident / Impact occurring	5	Definite	3	Possible
Impact Significance				
Consequence	2.45	Low	1.90	Low
Probability	5.00	Very High	4.00	High
Impact Significance	2.96	Medium	2.32	Low

Table C-8b: Assessment results for Impact 8b.

Impact 8b: Altered flow regime of the Jan Dissels River from the full expansion of the WWTW				
	Impact Without Mitigation		**Impact With Mitigation**	
Consequence				
Intensity of Impact	2	Low / Slightly Harmful	2	Low / Slightly Harmful

Duration of Impact	5	Beyond 20 years / Permanent	5	Beyond 20 years / Permanent
Extent / spatial scale of impact	2	Limited to local catchment	2	Limited to local catchment
Reversibility	3	Moderate cost / Moderate likelihood of success	2	Low-cost rehabilitation / Moderately high likelihood of success
Loss of irreplaceable resources	2	Low	1	None
Cumulative Impact	4	High	3	Medium
Probability				
Frequency of the Activity	5	Weekly to Monthly	5	Weekly to Monthly
Likelihood of the Incident / Impact occurring	5	Definite	4	Likely
Impact Significance				
Consequence	2.54	Low	2.27	Low
Probability	5.00	Very High	4.50	High
Impact Significance	3.03	Medium	2.71	Medium

Table C-9: Assessment results for Impact 9.

Impact 9: Nutrient and salt loading from golf course irrigation with treated effluent				
	Impact Without Mitigation		**Impact With Mitigation**	
Consequence				
Intensity of Impact	3	Medium / Harmful	2	Low / Slightly Harmful
Duration of Impact	5	Beyond 20 years / Permanent	5	Beyond 20 years / Permanent
Extent / spatial scale of impact	2	Limited to local catchment	1	Limited to project site
Reversibility	3	Moderate cost / Moderate likelihood of success	2	Low-cost rehabilitation / Moderately high likelihood of success
Loss of irreplaceable resources	1	None	1	None
Cumulative Impact	4	High	3	Medium
Probability				

Frequency of the Activity	5	Weekly to Monthly	5	Weekly to Monthly
Likelihood of the Incident / Impact occurring	4	Likely	3	Possible
Impact Significance				
Consequence	2.81	Medium	2.00	Low
Probability	4.50	High	4.00	High
Impact Significance	3.15	Medium	2.40	Low

Table C-10: Assessment results for Impact 10.

Impact 10: Water quality impairment in the Olifants River downstream of the Jan Dissels confluence				
	Impact Without Mitigation		**Impact With Mitigation**	
Consequence				
Intensity of Impact	2	Low / Slightly Harmful	1	Very Low / Non-harmful
Duration of Impact	5	Beyond 20 years / Permanent	5	Beyond 20 years / Permanent
Extent / spatial scale of impact	3	Multiple local catchments	3	Multiple local catchments
Reversibility	2	Low-cost rehabilitation / Moderately high likelihood of success	1	Passive restoration / High likelihood of success
Loss of irreplaceable resources	2	Low	1	None
Cumulative Impact	4	High	3	Medium
Probability				
Frequency of the Activity	5	Weekly to Monthly	5	Weekly to Monthly
Likelihood of the Incident / Impact occurring	3	Possible	2	Unlikely
Impact Significance				
Consequence	2.72	Medium	2.09	Low
Probability	4.00	High	3.50	Medium
Impact Significance	2.98	Medium	2.37	Low

Table C-11: Assessment results for Impact 11.

Impact 11: Altered flow regime of the Olifants River downstream of the Jan Dissels confluence				
	Impact Without Mitigation		Impact With Mitigation	
Consequence				
Intensity of Impact	1	Very Low / Non-harmful	1	Very Low / Non-harmful
Duration of Impact	5	Beyond 20 years / Permanent	5	Beyond 20 years / Permanent
Extent / spatial scale of impact	3	Multiple local catchments	3	Multiple local catchments
Reversibility	1	Passive restoration / High likelihood of success	1	Passive restoration / High likelihood of success
Loss of irreplaceable resources	1	None	1	None
Cumulative Impact	3	Medium	3	Medium
Probability				
Frequency of the Activity	5	Weekly to Monthly	5	Weekly to Monthly
Likelihood of the Incident / Impact occurring	2	Unlikely	1	Highly unlikely
Impact Significance				
Consequence	2.09	Low	2.09	Low
Probability	3.50	Medium	3.00	Medium
Impact Significance	2.37	Low	2.27	Low

Table C-12: Assessment results for Impact 12.

Impact 12: Altered hydrological regime and extent of the southern seep from increased effluent discharge				
	Impact Without Mitigation		Impact With Mitigation	
Consequence				
Intensity of Impact	1	Very Low / Non-harmful	1	Very Low / Non-harmful
Duration of Impact	5	Beyond 20 years / Permanent	5	Beyond 20 years / Permanent
Extent / spatial scale of impact	1	Limited to project site	1	Limited to project site

Reversibility	3	Moderate cost / Moderate likelihood of success	2	Low-cost rehabilitation / Moderately high likelihood of success
Loss of irreplaceable resources	1	None	1	None
Cumulative Impact	4	High	3	Medium
Probability				
Frequency of the Activity	5	Weekly to Monthly	5	Weekly to Monthly
Likelihood of the Incident / Impact occurring	4	Likely	4	Likely
Impact Significance				
Consequence	1.81	Low	1.63	Low
Probability	4.50	High	4.50	High
Impact Significance	2.35	Low	2.20	Low

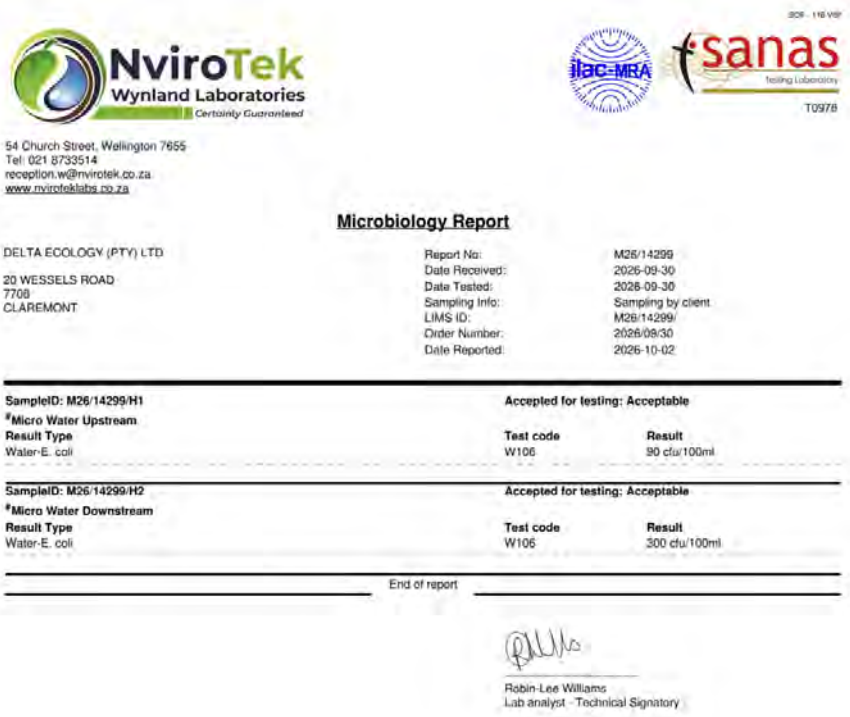
Table C-13: Assessment results for Impact 13.

Impact 13: Treated effluent quality in the southern seep				
	Impact Without Mitigation		**Impact With Mitigation**	
Consequence				
Intensity of Impact	1	Very Low / Non-harmful	1	Very Low / Non-harmful
Duration of Impact	5	Beyond 20 years / Permanent	5	Beyond 20 years / Permanent
Extent / spatial scale of impact	1	Limited to project site	1	Limited to project site
Reversibility	3	Moderate cost / Moderate likelihood of success	2	Low-cost rehabilitation / Moderately high likelihood of success
Loss of irreplaceable resources	1	None	1	None
Cumulative Impact	4	High	3	Medium
Probability				
Frequency of the Activity	5	Weekly to Monthly	5	Weekly to Monthly
Likelihood of the Incident /	5	Definite	4	Likely

Impact occurring				
Impact Significance				
Consequence	1.81	Low	1.63	Low
Probability	5.00	Very High	4.50	High
Impact Significance	2.45	Low	2.20	Low

Annexure D: Laboratory Certificates

NviroTek Wynland Laboratories, Microbiology Report M26/14299, reported 2 October 2026.



NviroTek Wynland Laboratories
Certainly Guaranteed

ilac-MRA sanas Testing Laboratory T0978

54 Church Street, Wellington 7655
Tel: 021 8733514
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www.nviroteklabs.co.za

Microbiology Report

DELTA ECOLOGY (PTY) LTD

20 WESSELS ROAD
7708
CLAREMONT

Report No:	M26/14299
Date Received:	2026-09-30
Date Tested:	2026-09-30
Sampling Info:	Sampling by client
LIMS ID:	M26/14299/
Order Number:	2026/09/30
Date Reported:	2026-10-02

SampleID: M26/14299/H1 — **Accepted for testing: Acceptable**

#Micro Water Upstream

Result Type	Test code	Result
Water-E. coli	W106	90 cfu/100ml

SampleID: M26/14299/H2 — **Accepted for testing: Acceptable**

#Micro Water Downstream

Result Type	Test code	Result
Water-E. coli	W106	300 cfu/100ml

End of report

Robin-Lee Williams
Lab analyst - Technical Signatory

Note:
cfu: Colony Forming Units
NC: Non Conformance
NG: No Growth
Not Detected = No Growth
No Growth defined as:
- Food: <10 cfu/g/ml
- Swabs: <9 cfu/swab
- Water/Wine: <1 cfu/ml/100ml/250ml
- Airplates: <1 cfu/airplate
* Not SANAS Accredited
#Customer supplied data
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The tests done only relates to samples done and received from clients. NviroTek Laboratories is not liable to any client for any loss or damages suffered which could directly or remotely be linked to our services. This report may not be reproduced, unless in full, without written approval of the laboratory.Opinions and interpretations expressed are outside the scope of SANAS accreditation.
Uncertainty of Measurement, methods used, and instruments, available on client request.

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NviroTek Wynland Laboratories, Chemistry Report S26/5257 (preliminary), reported 7 October 2026.

SOF-139 version: 02 S26/5257 **PAGE: 1 of 3**

NviroTek Wynland Laboratories

Verslag / Report

Chemistry

54 Church street, Wellington, 7655 | Tel: 021 873 3514 | reception.w@nvirotek.co.za | nviroteklabs.co.za

Verslag nr./Report no.:	S26/5257
Datum Monster Geneem/Sampling Date:	2026-10-01
Datum Ontvang/Date Received:	2026-10-01
Datum Gerapporteer/Date Reported:	2026-10-07

To/Aan:	DELTA ECOLOGY (PTY) LTD	**Representative/Verteenwoordiger:**	KIM VAN ZYL
		Farm Name/Plaas Naam:	
	27782758815	**Order/Bestel#:**	2026/09/30
	20 WESSELS ROADKENILWORTH EXTCLAREMONT7708	**Email:**	kimberley@deltaecologists.com

Lab Nr	**S26/5257/W1**	**Sample Reference #**	**Jan Dissels P**	**Sample Type**	**Water**	**Date Analysed**	**2026-10-01 - 2026-10-07**
Accepted for testing:	**Acceptable**						

Test	Unit	Results	Limit	Method	Test	Unit	Results	Limit	Method
Al (Aluminium) *	ug/l	382.64		C102	B (Boron)	mg/l	<0.10		C102
pH (25°C)	units	6.55		C101	Cu (Copper)	mg/l	<0.10		C102
EC (25°C)	mS/m	<8.4		C105	Fe (Iron)	mg/l	0.35		C102
COD	mg/l	32		C108	Mn (Manganese)	mg/l	0.10		C102
NAV/SAR	units	0.81		C120	Zn (Zinc)	mg/l	<0.10		C102
Suspended Solids *	mg/l	11		C119.1	As (Arsenic) *	ug/l	<10.00		C102
F (Fluoride) *	mg/l	<0.10		C107	Cd (Cadmium) *	ug/l	<3.00		C102
NO3-N (Nitrate as N) *	mg/l	2.0		C106	Co (Cobalt) *	ug/l	<10.00		C102
Cl (Chloride) *	mg/l	12.0		C110	Cr (Chromium) *	ug/l	<10.00		C102
NO2-N (Nitrite as N) *	mg/l	<0.02		C121	Hg (Mercury) *	ug/l	<6.00		C102
CN (Cyanide) *	mg/l	<0.010		C115	Ni (Nickel) *	ug/l	<10.00		C102
PO4-P (Phosphate) *	mg/l	<0.05		C104	Pb (Lead) *	ug/l	<10.00		C102
NH4-N (Ammonium as N)	mg/l	0.07		C109	Sb (Antimony) *	ug/l	<10.00		C102
Ca (Calcium)	mg/l	<5.00		C102	Se (Selenium) *	ug/l	<20.00		C102
Mg (Magnesium)	mg/l	1.23		C102	V (Vanadium) *	ug/l	<10.00		C102
K (Potassium)	mg/l	<5.00		C102	Oil Soap & Grease	mg/l			Subcontracted
Na (Sodium)	mg/l	7.84		C102					

Limit column: values are derived from the SANS 241-1:2015 standard and are provided in the absence of client specified limits.

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NviroTek Wynland Laboratories

Verslag / Report

Chemistry

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Verslag nr./Report no.:	S26/5257
Datum Monster Geneem/Sampling Date:	2026-10-01
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To/Aan:	DELTA ECOLOGY (PTY) LTD	Representative/Verteenwoordiger:	KIM VAN ZYL
		Farm Name/Plaas Naam:	
	27782758815	Order/Bestel#:	2026/09/30
	20 WESSELS ROADKENILWORTH EXTCLAREMONT7708	Email:	kimberley@deltaecologists.com

Lab Nr	S26/5257/W2	Sample Reference #	Jan Dissels River Downstream	Sample Type	Water	Date Analysed	2026-10-01 - 2026-10-07
Accepted for testing:	Acceptable						

Test	Unit	Results	Limit	Method	Test	Unit	Results	Limit	Method
Al (Aluminium) *	ug/l	86.64		C102	B (Boron)	mg/l	0.09		C102
pH (25°C)	units	7.35		C101	Cu (Copper)	mg/l	<0.10		C102
EC (25°C)	mS/m	59.80		C105	Fe (Iron)	mg/l	1.67		C102
COD	mg/l	56		C108	Mn (Manganese)	mg/l	0.11		C102
NAV/SAR	units	4.58		C120	Zn (Zinc)	mg/l	<0.10		C102
Suspended Solids *	mg/l	10		C119.1	As (Arsenic) *	ug/l	<10.00		C102
F (Fluoride) *	mg/l	<0.10		C107	Cd (Cadmium) *	ug/l	<3.00		C102
NO3-N (Nitrate as N) *	mg/l	2.2		C106	Co (Cobalt) *	ug/l	<10.00		C102
Cl (Chloride) *	mg/l	105.0		C110	Cr (Chromium) *	ug/l	<10.00		C102
NO2-N (Nitrite as N) *	mg/l	0.02		C121	Hg (Mercury) *	ug/l	<6.00		C102
CN (Cyanide) *	mg/l	<0.010		C115	Ni (Nickel) *	ug/l	<10.00		C102
PO4-P (Phosphate) *	mg/l	<0.05		C104	Pb (Lead) *	ug/l	<10.00		C102
NH4-N (Ammonium as N)	mg/l	6.00		C109	Sb (Antimony) *	ug/l	<10.00		C102
Ca (Calcium)	mg/l	14.25		C102	Se (Selenium) *	ug/l	<20.00		C102
Mg (Magnesium)	mg/l	6.72		C102	V (Vanadium) *	ug/l	<10.00		C102
K (Potassium)	mg/l	19.16		C102	Oil Soap & Grease	mg/l			Subcontracted
Na (Sodium)	mg/l	83.68		C102					

NOTAS / NOTES:

Verslag goedgekeur deur / Report approved by:

Ushca de Haast	Lean Yssel
ushca.dehaast@nviroteklabs.co.za	lean.y@nvirotek.co.za
Operational Leader	Lab analyst - Technical Signatory

Limit column: values are derived from the SANS 241-1:2015 standard and are provided in the absence of client specified limits.

NviroTek Wynland Laboratories

Verslag / Report

Chemistry

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BELANGRIK / IMPORTANT

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** Results marked with ** are Subcontracted Tests and are not included in the Schedule of Accreditation for this laboratory.

< Where a result is reported as less than (<) a value, the result obtained is below the limit of detection for the specific analyte.

Customer supplied data.

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End of Report

Limit column: values are derived from the SANS 241-1:2015 standard and are provided in the absence of client specified limits.