

Hemel en Aarde Wellfields Expansion Project

***HAV1 Repl. and T4/5 Pipelines and Pumphouse
Construction – Section 21(c) and (i) Water Use Licence
Conditions Monitoring Report January –September 2025***



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List of Abbreviations

%	-	percent
~	-	approximately
<	-	less than
>	-	greater than
µg	-	microgram
a	-	annum
ASPT	-	Average Score Per Taxon
BGCMA	-	Breede-Gouritz Catchment Management Agency
BOCMA	-	Breede-Olifants Catchment Management Agency
CBA	-	Critical Biodiversity Area
DWAF	-	Department of Water Affairs and Forestry (1994-2009)
DWS	-	Department of Water and Sanitation (post-2014)
e.g.	-	for example
EC	-	electrical conductivity
FEN	-	Freshwater Ecologist Network
GSM	-	gravel, sand and mud
HAV	-	Hemel en Aarde Valley borehole
HR	-	Hamilton Russell
i.e.	-	in other words
IHAS	-	Invertebrate Habitat Assessment System
l	-	litres
LM	-	local municipality
m	-	metre
m ³	-	cubic metre
Ma	-	millions of years
Ma	-	millions of years
MAP	-	mean annual precipitation
MAT	-	mean annual temperature
MAT _{mn}	-	average monthly minimum temperature
MAT _{mx}	-	average monthly maximum temperature
mbgl	-	metres below ground level
mg	-	milligram
mm	-	millimetre
mS	-	milliSiemens
No.	-	number
NTU	-	Nephelometric Turbidity Units
°C	-	degrees Celsius
OLM	-	Overstrand Local Municipality
PES	-	Present Ecological Status
Repl.	-	Replacement
SANAS	-	South African National Accreditation System
SANBI	-	South African National Biodiversity Institute
SANSA	-	South African National Space Agency
SASS5	-	South African Scoring System 5
SAWQG	-	South African Water Quality Guidelines
SAWS	-	South African Weather Service
TDS	-	total dissolved solids
TMG	-	Table Mountain Group
TS	-	Tokara Siberia
TSS	-	total suspended solids
TWQR	-	Target Water Quality Range
WCBSP	-	Western Cape Biodiversity Spatial Plan
WUL	-	water use licence

1. INTRODUCTION

1.1 Background

The greater Hermanus area within the Overstrand Local Municipality (OLM) is supplied by a combination of surface water from the De Bos Dam and Peninsula Aquifer groundwater from the Gateway, Camphill and Volmoed wellfields. The Camphill and Volmoed Wellfields (termed the Hemel en Aarde Wellfields in combination) Section 21(a) WUL (No. 18/G40H/A/2377) was awarded on 8th December 2013 (and amended on the 1st December 2021) for groundwater abstraction of up to 1.6 million m³/a, which will be utilised in three stages of 0.8 million m³/a (Stage 1), 1.2 million m³/a (Stage 2) and 1.6 million m³/a (Stage 3). Upgrade to Stage 2 (1.2 million m³/a) was authorised by the Department of Water and Sanitation (DWS) and the then Breede-Gouritz Catchment Management Agency (BGCMA, now the Breede-Olifants CMA [BOCMA]) on 20 July 2016, due to the adherence to licence conditions and monitoring data indicating sustainable abstraction during Stage 1 of the WUL. These two wellfields have been in production since September 2013 and are operated in association with the Gateway Wellfield by Veolia Water Technologies South Africa on behalf of the OM, with support from Umvoto.

The Camphill and Volmoed Wellfields reached their production potential in terms of Stage 2 of the WUL, and thus need to be optimised and/or expanded to increase to the Stage 3 WUL volume of 1.6 million m³/a and meet the growing water demand in Hermanus. The Hemel en Aarde Wellfields Expansion Project in Hermanus comprises the following:

- The drilling of up to three new production boreholes (T4/5, T4/6 and HAV10).
- The replacement via re-drilling of the HAV1 borehole (which has never been utilised as a production borehole due to construction issues) with a new adjacent, wider diameter production borehole (HAV1 Replacement or HAV1 Repl.).
- The deepening of an existing monitoring borehole (T4/3) and potentially conversion to a production borehole (this has been undertaken, and due to the low yields still present following deepening, T4/3 will remain a monitoring borehole).
- The drilling of a new monitoring borehole T4/7.
- The installation of connector pipes between the production boreholes and the existing bulk water pipeline.
- The installation of electrical reticulation and transformers to supply power to the wellfield.

The production boreholes will be drilled/tested and then developed for abstraction with the construction of borehole chambers, and the installation of wellheads and production pumps. The connector pipelines will link the boreholes to the existing main Hemel en Aarde Wellfields bulk water pipeline, which currently feeds groundwater from the existing production boreholes to the Preekstoel Water Treatment Works in Hermanus. New electrical reticulation will be provided to supply power to production boreholes. Production boreholes are expected to be 200-300 metres (m) deep and ~0.25 m diameter at surface, tapering to narrower diameters with depth. The surface wellhead structure and pump are to be enclosed in an above ground borehole chamber, with dimensions of ~4 m x 2 m in plan and ~2 m in height.

Construction activities associated with the Hemel en Aarde Wellfield Expansion Project will take place across several farm portions/properties within the Hemel en Aarde Valley in the greater Hermanus area, namely (see **Figure 2-2**):

- Hemel en Aarde 3/585 (HAV10 and HAV1 Repl.).
- Farm 1/586 (T4/3).
- Farm RE/586 (T4/5, T4/6 and T4/7).

1.2 Monitoring Requirements

The construction activities trigger the need for environmental authorisation and water use authorisation, both of which were granted. The Section 21(c) and (i) WUL (No. 18/G40H/A/2377) was issued on 12th December 2023, stipulating specific monitoring requirements as part of its WUL conditions (Appendix II Conditions 2.3, 3 and 4):

- Condition 2.3.1 – In-stream water quality must be analysed on a two-weekly basis during construction, otherwise monthly at monitoring points both upstream and downstream of the activities, until pre-construction water quality levels have been reached.
- Condition 2.3.2 – Monitoring must be undertaken as set out in Condition 3 below.
- Condition 2.3.3 – Activities must be scheduled to take place during the dry seasons when flows are lowest where reasonably possible.
- Condition 2.3.4 – The licensee must ensure that the quality of the water to downstream water users does not decrease because of the water use activities listed under Condition 1.1.
- Condition 3.1 – The monitoring plan must be implemented, and reporting done to the Delegated Authority as stipulated under Condition 3.2.
- Condition 3.2 – Six (6) monthly monitoring reports must be submitted to the Delegated Authority for the duration of the construction phase and yearly thereafter or until otherwise agreed in writing with the Regional Head/CEO.
- Condition 4.1 – At least two water quality monitoring points, one upstream and one downstream of the affected length of the watercourse/s.
- Condition 4.2 – A bio-monitoring programme (SASS) must be implemented along the affected length of the watercourse/s and must include a habitat assessment.
- Condition 4.3 – Exact positions of monitoring points must be indicated on the master layout plan (including their co-ordinates).

Umvoto was appointed by the OLM under iX engineers to conduct a freshwater monitoring programme, including water quality monitoring and a rapid South African Scoring System 5 (SASS5) bio-monitoring field assessment (Dickens and Graham, 2002), as per the conditions above. This programme focused on watercourses that may be affected by discharging groundwater during the drilling and testing of the HAV1 Repl. and T4/5 production boreholes, as well as by surface runoff during the construction of the pumphouses and installation of the connector pipelines.

1.3 Purpose and Schedule of the Monitoring Report

This monitoring report's objective is to document the results of the freshwater monitoring programme implemented for the pipeline and pumphouse construction of the HAV1 Repl. and T4/5 boreholes between March and September 2025, and to assess adherence to the Section 21(c) and (i) WUL conditions (specifically Appendix II Conditions 2.3 and 4).

The construction activities in the six-monthly reporting period included the construction of the HAV1 Repl. and T4/5 pumphouses and installation of their respective connector pipelines. The HAV1 Repl. and T4/5 pumphouses were constructed simultaneously from the end of March 2025 until the beginning of May 2025. Following this, the trenching started for the installation of a ~700 m connector pipeline for T4/5, which was ongoing until the end of August 2025. No major trenching was required to connect the HAV1 Repl. borehole to the mains line (~6 m of pipeline will be installed).

2. SITE DESCRIPTION

2.1 Locality

All activities relating to the expansion of the Hemel en Aarde Wellfields are taking place within the Hemel en Aarde Valley located northwest of the town of Hermanus in the OLM (see **Figure 2-1**). A detailed locality map of the proposed Peninsula Aquifer production boreholes is provided in **Figure 2-1**, coordinates for the HAV1 Repl. (210 m deep) and T4/5 (179 m deep) production boreholes are listed in **Table 2-1**. Specific start and end positions of pipelines, as well as the length for each borehole are specified in **Table 2-2** and maps showing their location relevant to existing mains pipeline infrastructure can be seen in **Figure 2-2**.

Table 2-1 Positions and details of the HAV1 Repl. and T4/5 production boreholes.

Borehole Name		Latitude	Longitude	Elevation (mamsl)	Depth (mbgl)	Target Aquifer
Production Borehole	HAV1 Repl.	-34.398480°	19.209470°	108	210	Peninsula
	T4/5	-34.375420°	19.246180°	153	179	Peninsula

Table 2-2 Positions and details of the HAV1 Repl. and T4/5 production borehole pipelines.

Pipeline Name		Start point		End point		Total Length
		Latitude	Longitude	Latitude	Longitude	(m)
Production Borehole	HAV1 Repl.	-34.398482°	19.209471°	-34.398447°	19.209419°	6
	T4/5	-34.375420°	19.246257°	-34.374667°	19.239756°	639

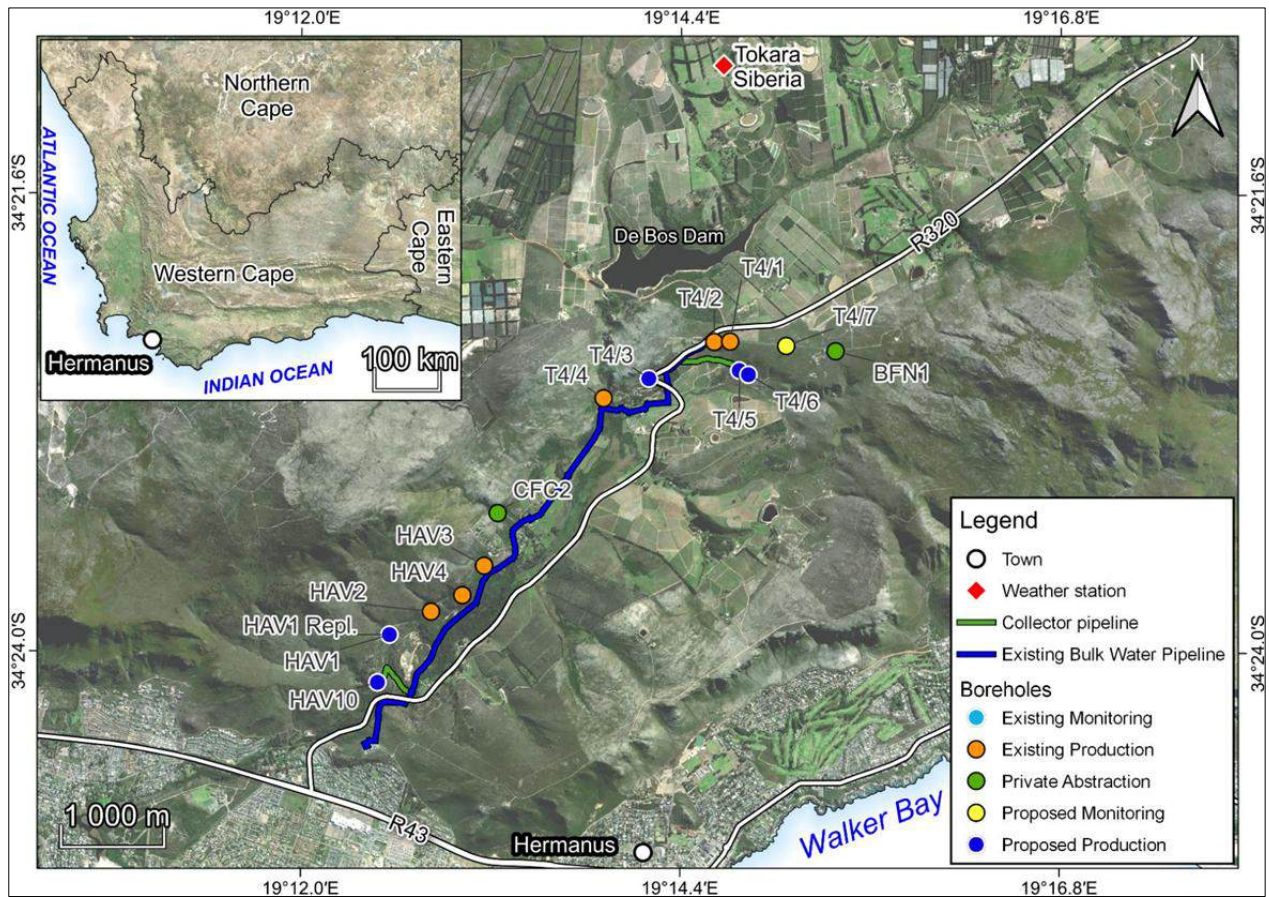


Figure 2-1 Overview of the Hemel en Aarde Valley showing borehole locations for the Hemel en Aarde Wellfield Expansion Project. Proposed new production boreholes (dark blue circles – T4/5, T4/6, HAV1 Repl. and HAV10; T4/3 deepening has been completed and remains a monitoring borehole due to low yields) are shown with collector pipelines (green line) joining to the existing arterial pipeline (blue line). Proposed new monitoring boreholes (yellow circles – T4/7), existing production boreholes (orange circles – HAV2, HAV3, HAV4, T4/1, T4/2 and T4/4), and selected existing Peninsula Aquifer monitoring boreholes (green circles – CFC2 and BFN1) are also shown. The De Bos Dam can be seen to the north of the wellfield.

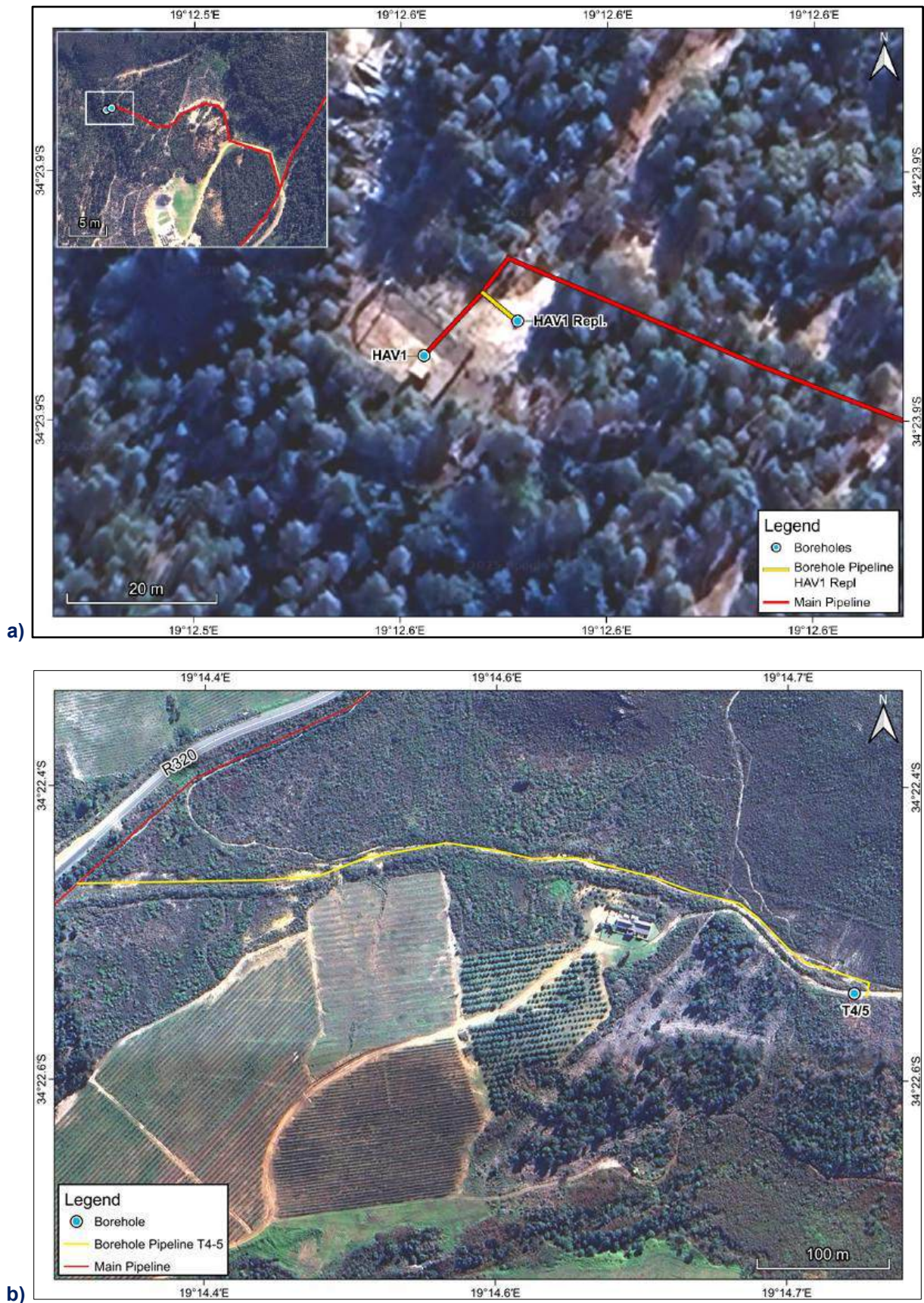


Figure 2-2

HAV1 Repl. production borehole (blue circle) located adjacent to the existing HAV1 borehole on Hemel en Aarde 3/585 (a). T4/5 production borehole (blue circle) on Farm RE/586 (b). Pipelines for both boreholes (yellow line) were installed and connected to the existing mains water line (red line).

2.2 Climate

The climate of the Hermanus area is warm, temperate, and dry; and is classified as “Csb” according to the Köppen and Geiger classification system (Beck et al., 2018). Regionally, Hermanus falls within the Western Cape Mediterranean climate regime, characterised by cold, wet winters and warm, dry summers.

Hermanus occurs in Rainfall Catchment Zone G4B and surface water quaternary catchment G40H, with the mean annual precipitation (MAP) (based on a 1920-2009 dataset from WR2012) is 752 mm. Rainfall is influenced considerably by topography and relief – the various mountain ranges to the northwest (Onrus Mountains), north (Babilonstoring Mountains) and northeast (Fernkloof Mountains) of Hermanus represents the high precipitation recharge area of the locally utilised Table Mountain Group (TMG) aquifers.

SA Atlas of Climatology and Agrohydrology temperature data (Schulze, 2009) for the Hermanus region, based on a 50-year recording period (1950-2000), records the mean annual temperature (MAT) for Hermanus as 16°C, while average monthly maximum (MAT_{mx}) and minimum temperatures (MAT_{mn}) range between 21°C and 12°C, respectively.

Rainfall was measured at five weather stations between January 2024 to November 2025 (see **Figure 2-3**): three within Hermanus town (South African National Space Agency [SANSA], South African Weather Services [SAWS], and the Overstrand Municipality station [OM]) and two at a higher altitude within the Hemel en Aarde Valley (Hamilton Russell [HR] and Tokara Siberia [TS]) (see OM [2025] for details on longer-term climate monitoring). The monthly rainfall bar graph (see **Figure 2-3**) shows that 53% of the rainfall occurred during winter (June to August), with stations recording between 35 mm and 205 mm per month.

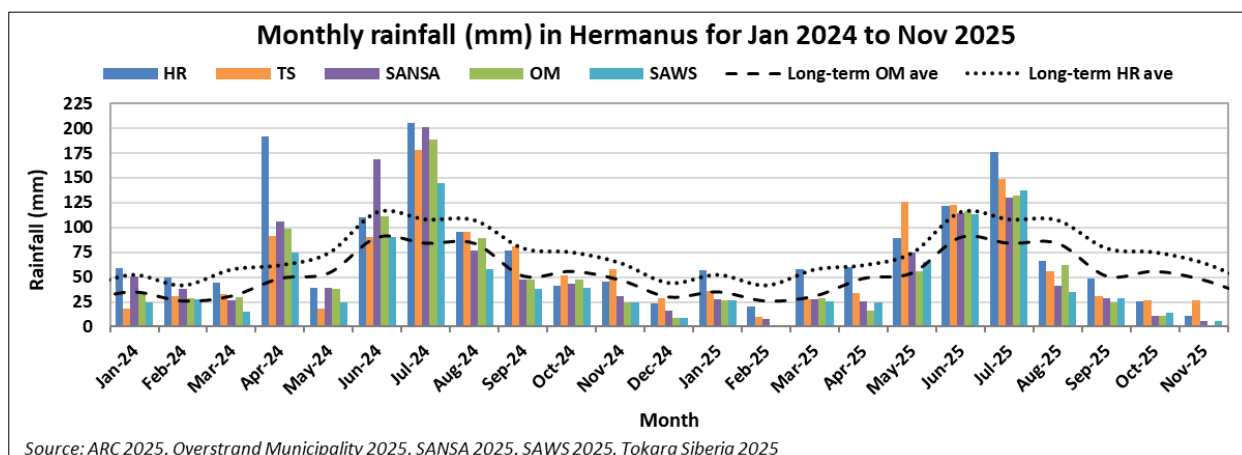


Figure 2-3 Monthly rainfall (mm) recorded at the five weather stations (HR = Hamilton Russell, TS = Tokara Siberia, SANSA = South African National Space Agency, OM = Overstrand Municipality, and SAWS = South African Weather Services) in the greater Hermanus area for January 2024 to November 2025. The long-term average for OM (1991-2020) and HR (2003-2024) are shown by the dashed and dotted black lines, respectively.

July 2024 and 2025 recorded above the long-term averages across the stations; while May, October and November 2024, as well as February, August and September 2025 recorded below the long-term averages, suggesting overall a good rain year for 2024 but a poor rain year for 2025. It is noted that July 2024 recorded record-breaking rainfall in southwestern parts of South Africa, with the highest monthly rainfall (three times the rainfall average) recorded since records started in 1956 at Cape Town International Airport. The spring (March to May) and autumn (September to November) period produced 37% of annual rainfall, with rainfall in April 2024

recording 192 mm at the HR station and May 2025 recording 125 mm at the TS station. The high April 2024 rainfall was linked to a cut-off low system where 188 mm of rain fell between 4th and 10th April; whereas the high May 2025 rainfall was linked to three separate cut-off low systems where 37 mm of rain fell over the 1st and 2nd, 30 mm over the 10th and 11th, and 37 mm over the 20th to 22nd May, respectively. Summer (December to February) rainfall for this reporting period contributed 10% for the year, with rainfall in January 2024 recording 59 mm at the HR station and 57 mm in January 2025 (although summer rainfall in the greater Hermanus area was generally low for December 2024 to February 2025).

2.3 Geology

The main stratigraphic units represented in the study area belong to the Malmesbury Group, Cape Granite Suite, TMG, Bokkeveld Group and Bredasdorp Group (see **Table 2-3**), with the geology and hydrogeology of the greater Hermanus area being outlined in detail in OLM (2024).

Rocks of the Malmesbury Group, intruded by the Cape Granite Suite, are the oldest rocks in the region (Namibian-Cambrian; ~800-510 million years old [Ma]), and form the basement upon which the thick layers of the Ordovician to Devonian (~480-375 Ma) TMG and Bokkeveld Group sediments were deposited (with the latter two groups forming the Cape Supergroup with the Witteberg Group). Granite outcrops can be found north of Stanford at the foot of the Klein River Mountains, and in the Hemel en Aarde Valley north of the De Bos Dam along the base of the Babilonstoring Mountains.

The TMG dominates the Hermanus region as a whole and is composed of the (from oldest to youngest) Peninsula, Pakhuis, Cedarberg, Goudini, Skurweberg and Rietvlei Formations. Due to the folded and resistant nature of the fractured quartzites of the Peninsula and Skurweberg Formations, the TMG outcrops as steep, rocky hills and mountains i.e. the east-west trending topographic backbone of the Onrus, Babilonstoring, Fernkloof and Klein River Mountains. Geological mapping of the area by Umvoto in 2007 indicated that the area to the southeast of the Hermanus Fault is underlain by the Skurweberg Formation, and not Peninsula Formation as shown in the existing 1:250 000 Worcester 3319 geological map (Umvoto, 2007). Consequently, the Hermanus Fault is a normal (extensional) fault dipping to the southeast along its entire trace, with the downthrown hanging wall block to the southeast and up-thrown footwall block to the northwest.

The Cape Supergroup and underlying basement rocks were subsequently highly deformed (faulted, fractured and folded) by the Permian-Triassic (~280-230 Ma) Cape Orogeny (i.e. tectonic mountain building event), with the thick quartzitic sandstone-rich formations (specifically the Peninsula, Skurweberg and Rietvlei Formations of the TMG) being highly brecciated along major fault zones and forming excellent secondary fractured aquifers.

The Hermanus coastal platform is intermittently covered by Quaternary sediments of the Bredasdorp Group. The Bredasdorp Group was deposited across the exposed marine terraces from the Late Cenozoic to Present (~20-0 Ma) and forms the youngest formations within the study area. The Bredasdorp Group consists mainly of calcareous-rich aeolian (dune) sands and limestones, and fluvial shelly gravels (see **Table 2-3**) and extends north-eastwards from the coastal plain of Walker Bay towards Stanford.

Table 2-3 Stratigraphy of the Hermanus area (acronyms as per the 1:250 000 3319 Worcester geological map).

Group	Formation	Lithology	Age (Ma)
Bredasdorp	Strandveld (Qs)	Unconsolidated white dune sand	Holocene (0.01-0 Ma)
	(unnamed) (Qg)	Sandy soil and loam	Early-Late Pleistocene (~1-0.01 Ma)
	Waenhuiskrans (Qw)	Semi-consolidated to unconsolidated dune sand and calcrete, locally highly calcareous	
	Klein Brak (Qk)	Consolidated to semi-consolidated shelly coarse sand, gravel, conglomerate and coquina	Early Pleistocene (~2.5-1 Ma)
Major unconformity			
	False Bay Suite	Dolerite	Early Cretaceous (136 Ma)
Major hiatus and unconformity – Cape Orogeny (~280-230 Ma) and Gondwana breakup (~180-110 Ma)			
Bokkeveld	Gamka (Dga)	Dark grey feldspathic sandstone	Middle Devonian (~390-385 Ma)
	Gydo (Dg)	Black to dark grey shale/mudstone and siltstone	
Table Mountain	Rietvlei (Dr)	Feldspathic sandstone, siltstone and minor shale	Early Devonian (~416-390 Ma)
	Skurweberg (Ss)	Cross-bedded quartzite (quartzitic sandstone)	Silurian ~445-416 Ma
	Goudini (Sg)	Reddish brown-weathering sandstone, siltstone and shale	
	Cedarberg (O-Sc)	Dark grey to black shale (lower Soom Member); siltstone and fine sandstone (upper Disa Member)	
	Pakhuis (Opa)	Massive tillite (glacial conglomerate) and sandstone	Ordovician (~480-445 Ma)
	Peninsula (Ope)	Thickly bedded quartzite (quartzitic sandstone)	
Major unconformity			
Cape Granite Suite	Hermanus Pluton (N-Chp)	Coarse-grained to porphyritic granite	Cambrian (~520 Ma)
Malmesbury	Tygerberg (Nt)	Metasediments (shale, phyllite, greywacke, hornfels)	Namibian (~800-510 Ma)

2.4 Hydrogeology

The main targeted aquifers for groundwater use in the region include the deep fractured Peninsula Aquifer (formed by the Peninsula Formation and targeted by OLM for municipal supply, and some farmers within the Hemel en Aarde Valley), the shallower fractured Nardouw Aquifer (formed by the Rietvlei and Skurweberg Formations and targeted by Hermanus residents and farmers) and the thin surficial, primary or sandy Quaternary Aquifer (targeted by residential wellpoints).

The Peninsula Aquifer is hydraulically separated into various fault-bounded compartments within the Hermanus area that represent structural sub-areas, across which it is interpreted that no hydraulic connection exists due to the sealing nature of annealed fault cores (Umvoto, 2007). In some of these compartments the Peninsula Aquifer is overlain by confining aquitard units e.g. the

Pakhuis, Cedarberg and Goudini Formations of the TMG (which combined form the Winterhoek Mega-aquitard), and the shale-rich Ceres Subgroup of the Bokkeveld Group. The Nardouw Aquifer is hydraulically separated from the Peninsula Aquifer by the Winterhoek Mega-aquitard, and therefore municipal groundwater abstraction from the Peninsula Aquifer does not impact on private residential and agricultural groundwater abstraction from the Nardouw Aquifer (as indicated by long-term groundwater level monitoring in Hermanus and the Hemel en Aarde Valley). The three OLM municipal TMG wellfields target the Peninsula Aquifer along the following major structures:

- Gateway Wellfield – confined Peninsula Aquifer (depths of >100 metres below ground level [mbgl]) along the damage zones of the ~NE-SW to ~E-W orientated Hermanus, Gateway and Mount Pleasant Faults.
- Camphill Wellfield – semi-confined to confined Peninsula Aquifer along the damage zone of the ~NE-SW orientated Attakwaskloof Fault.
- Volmoed Wellfield – unconfined to semi-confined Peninsula Aquifer along the damage zone of the ~NW-SE orientated Fernkloof Fault and ~NE-SW orientated Attakwaskloof Fault.

The Bredasdorp Group, which forms the relatively thin (~5-10 m thick) surface alluvial/sandy or primary Quaternary Aquifer, overlies TMG units along the Hermanus coastal platform (which is in hydraulic connection with whichever TMG aquifer underlies the coastal sediment). Many private wellpoints within the various Hermanus suburbs penetrate the Quaternary Aquifer and are predominantly used for domestic irrigation purposes.

2.5 Hydrochemistry

All three aquifers (Peninsula, Nardouw and Quaternary Aquifers) are characterised by acidic pH values between 3-6. The low pH values are a result of these aquifers being quartz (silica) rich (>95%), having a low buffering capacity against organic (humic and fulvic) acids produced by decomposing fynbos vegetation in recharge zones. The precipitation of hydrated iron, manganese and aluminium oxides can also release hydrogen ions into the aqueous system, causing further acidification of the groundwater. pH also tends to exhibit seasonality i.e., more acidic water in the end of winter/spring samples compared to summer samples, which could possibly be due to increased rainfall in winter flushing increase amounts of organic acids from the soil into the groundwater system, as well as oxygenated rainwater influx causing the precipitation of hydrated aluminium, iron and manganese oxide and the associated acidification of groundwater.

High iron and manganese concentrations are present within the Peninsula and Nardouw Aquifers, due to hydrothermal oxide mineralisation via fractured zones during the Cape Orogeny, combined with later secondary supergene enrichment by groundwater flowing along these preferential flow paths. Weathered sediment from these mineralised/supergene zones occurs within the Bredasdorp Group sediments, resulting in high concentrations of iron and manganese also commonly occurring within the Quaternary Aquifer. Relatively deep aquifers such as Peninsula and Nardouw Aquifers usually have minimal dissolved oxygen, and in conjunction with the acidic nature of the groundwater this further results in dissolved manganese and iron entering the groundwater system.

2.6 Ecological Site Classification

The Hemel en Aarde Valley is comprised mostly of fynbos, thicket/dense bush, cultivated orchards and vineyards. The ecological site classification as per the 2017 Western Cape Biodiversity Spatial Plan (WCBSP; produced by the South African National Biodiversity Institute [SANBI]) mapping of biodiversity, vegetation types, terrestrial ecosystem status, and where applicable wetland status, is given in **Table 2-4**. A description of the land use type as well as any possible heritage implications are also included.

Table 2-4 HAV1 Repl. and T4/5 borehole site ecological classification.

Criteria	HAV1 Repl.	T4/5
Critical Biodiversity Areas (CBA)	Within CBA2 and adjacent CBA1	Within CBA2 and adjacent CBA1 and ESA1
Desired Management Objectives ¹	CBA2: Maintain in a functional, natural or near-natural state, with no further loss of natural habitat. These areas should be rehabilitated. CBA1: Maintain in a natural or near-natural state, with no further loss of habitat. Degraded areas should be rehabilitated. Only low-impact, biodiversity-sensitive land uses are appropriate.	CBA2 – see HAV1 Repl. CBA1 – see HAV1 Repl. ESA 1: Maintain in a functional, near-natural state. Some habitat loss is acceptable, provided the underlying biodiversity objectives and ecological functioning are not compromised.
Vegetation ²	Overberg Sandstone Fynbos	Overberg Sandstone Fynbos with Elim Ferricrete Fynbos. No plant Species of Conservation Concern recorded.
Proximity to Wetland (m)	~8.5 m	~116 m
Wetland Type ³	Seasonal mountain stream in vicinity*	Hillslope seep wetland in vicinity*
Ecosystem Status	Critically Endangered (CR)	
Rivers and Proximity (m)	Onrus River, ~457 m	Onrus River, ~1 328 m
Heritage	None	
Land Use Type	Within existing borehole (HAV1) footprint	Road reserve and access track

* The seasonal mountain streams and hillslope seep wetland were avoided, and construction occurred away from these so as not to contaminate or destroy the natural ecosystems therein.

¹ Western Cape Biodiversity Spatial Plan Handbook, 2017 pg. 55

² SANBI, 2018 via CapeFarmMapper

³ CSIR via CapeFarmMapper

3. MONITORING ACTIVITIES

3.1 Monitoring Sites

As per the Hemel en Aarde Wellfields Section 21(c) and (i) WUL conditions (see **Section 1.2**), two monitoring points per borehole were identified and utilised to monitor the impact of surface water runoff near or into watercourses during the construction of the HAV1 Repl. and T4/5 borehole pumphouses and installation of their respective connector pipelines (see **Table 3-1**, **Figure 3-1** and **Figure 3-2**). These monitoring points were located along watercourses (in this case non-perennial tributaries of the Onrus River) that passed both borehole sites, where monitoring sites both upstream and downstream of the construction works could be located. The Onrus River in the vicinity of the HAV1 Repl. borehole underwent significant alteration during the end-September 2023 flooding, with other subsequent construction activities (unrelated to the Hemel en Aarde Expansion Project) occurring within the river (Camphill bridge rebuilding and pipeline repair) during borehole drilling, making it unsuitable for monitoring.

Upstream monitoring sites act as unimpacted reference conditions (i.e. if unimpacted reference conditions are changing due to unknown factors, then it may be reasonable that these changes can be expected to also occur at sites downstream from drilling activities, and not be related to drilling activities). Downstream monitoring sites act as impact monitoring sites, to determine if surface water runoff during construction activities had any significant impact to watercourses. In-stream water quality monitoring was undertaken before construction occurred to establish baseline conditions at all sites, and thereafter every two weeks (as per Section 21(c) and (i) WUL conditions [Appendix II Conditions 2.3 and 4]) until reference conditions were restored. Baseline Monitoring of the HAV1 Repl. and T4/5 watercourse sites occurred on the 14th January 2025 and continued from when construction activities began on the 27th March 2025 until the 8th September 2025.

SASS5 bio-monitoring occurred on a monthly basis in the vicinity of the same upstream and downstream monitoring sites at each borehole (see **Table 3-1**, **Figure 3-1** and **Figure 3-2**), on the 14th January 2025, 3rd April 2025, 5th May 2025, 22nd May 2025, 30th June 2025 and 3rd September 2025. In this case, all January 2025 data is representative of baseline conditions prior to pipeline and pumphouse construction, the April-June 2025 data is representative of the construction phase for both HAV1 Repl. and T4/5 boreholes and September 2025 represents the post-construction phase. All construction activities were scheduled during the dry summer season (January-March) when surface water flows were lowest. However, due to contractor delays the construction continued throughout the wet winter season.

Table 3-1 Upstream and downstream monitoring sites used for watercourse water quality and SASS5 bio-monitoring sampling for the HAV1 Repl. and T4/5 boreholes.

Borehole Name	Monitoring Site Name	Latitude	Longitude	Elevation (mamsl)
HAV1 Repl.	HAV1 Repl. Upstream	-34.398658	19.209021	105
	HAV1 Repl. Downstream	-34.402372	19.210063	59
T4/5	T4/5 Upstream	-34.377295	19.245340	123
	T4/5 Downstream	-34.377511	19.241453	103

3.2 Water Quality

As stipulated in Appendix II Conditions 2.3 and 4 of the Section 21(c) and (i) WUL, in-stream water quality monitoring must be undertaken to ensure no contamination of watercourses occurs downstream of construction activities due to stormwater runoff. Grab water samples were collected (as per relevant sampling procedures) from the monitoring sites located upstream and downstream of construction activities (see **Figure 3-1** and **Figure 3-2A**), and submitted to SANAS-accredited Integral Laboratories for analysis of macrochemical parameters listed in Appendix II Condition 2.3.1 of the Section 21(c) and (i) WUL – pH, electrical conductivity (EC), total suspended solids (TSS), turbidity, total dissolved solids (TDS), and fats, oil and grease.

The hydrochemical results were compared to the South African Water Quality Guidelines (SAWQG) Target Water Quality Range (TWQR) for aquatic ecosystems (Department of Water Affairs and Forestry [DWAF], 1996), to evaluate possible water quality exceedances caused by construction activities, and to establish whether baseline conditions were restored over time. There are no Breede-Gouritz Water Management Area Resource Quality Objectives (RQOs; DWS, 2020) in terms of surface water quality for rivers within the G40H catchment for comparative purposes.

3.3 SASS5 Bio-monitoring

The SASS5 is geared at assessing river water quality and river health based on the assemblage of aquatic macro-invertebrates identified amongst stoney, vegetation, and gravel, sand and mud (GSM) biotopes at a given river reach (measured in the vicinity of the HAV1 Repl. and T4/5 upstream and downstream sites by Freshwater Ecologist Network [FEN] Consulting and Umvoto; see **Table 3-1**, **Figure 3-1** and **Figure 3-2**). Each macro-invertebrate is assigned a SASS5 sensitivity score that ranges from 1-15, which is indicative of the degree of tolerance to poor water quality, with a score of 1 indicating highly tolerant, and a score of 15 highly intolerant. The sensitivity scores of the identified taxa (families and orders) are summed per biotope to calculate the SASS5 score, which when divided by the number of different taxa observed in that biotope determines the Average Score Per Taxon (ASPT; the average sensitivity of aquatic macro-invertebrates per biotope). It is also possible to calculate these indices across all biotopes to determine the SASS5 Total Score, number of taxa and ASPT per site. SASS5 scores are then used to derive the Present Ecological Status (PES) of the river system, which is classified as follows: Class A (Pristine), Class B (Largely Unmodified), Class C (Moderately Modified), Class D (Largely Modified), and Class E/F (Severely to Critically Modified).

Additionally, a habitat assessment was also undertaken using the Invertebrate Habitat Assessment System (IHAS) (McMillan, 1998), which was informed by a survey of general habitat integrity to evaluate the suitability of habitat conditions in allowing for a diverse community of aquatic macro-invertebrates (see **Section 4.2**).

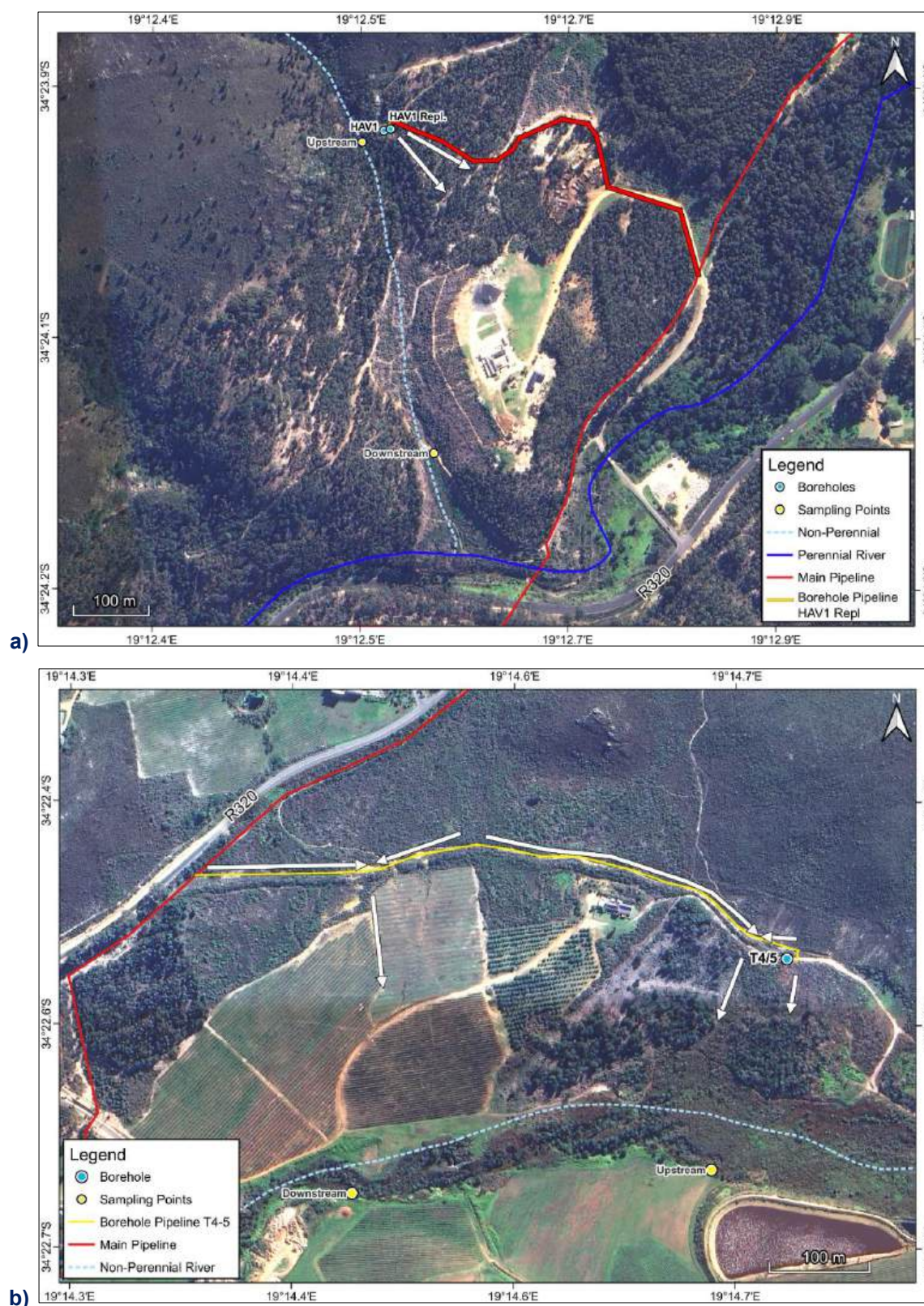


Figure 3-1 Location of upstream and downstream (yellow circles) monitoring sites along non-perennial Onrus River tributaries (light blue lines) in the vicinity of the HAV1 Repl. (a) and T4/5 (b) production boreholes (blue circles). White arrows indicate general direction of surface water flow during construction and trenching.



Figure 3-2 Onrus River tributary reaches sampled upstream and downstream (respectively) of the proposed HAV1 Repl. (a) and (b) and T4/5 (c) and (d) production borehole construction activities locations for water quality and SASS5 bio-monitoring.

4. MONITORING RESULTS

4.1 Water Quality

Both Onrus River tributaries/watercourses assessed in this report are categorised as non-perennial rivers (i.e. seasonal in nature, and generally only flow during winter/spring and after heavy unseasonal rainfall events), which generally characterised by unpredictable flow regimes and fluctuating water quality. The HAV1 Repl. Downstream site was dry and unable to be sampled between 27th of March and the 08th of May 2025.

Water quality results from the HAV1 Repl. and T4/5 upstream and downstream monitoring sites are shown in **Table 4-1** and **Table 4-2** respectively, with the Integral Laboratories results sheets available in **Appendix A**. Hydrochemical constituents within both tables that exceed the SAWQG TWQR for aquatic ecosystems are highlighted in green (see **Table 4-1** and **Table 4-2**):

- The baseline values for pH (6.0) at T4/5 taken on the 14/01/2025 were uncharacteristically high for the area and as such could not be used as an indicative baseline. The results for pH were therefore compared with the baseline (5.39 upstream and 5.43 downstream) which was taken on the 16/02/2024 prior to the drilling and testing of the boreholes in early 2024 (Umvoto South Africa, 2024).
- pH within both monitored Onrus River tributaries is naturally acidic (~4.5-5 and ~4.0-4.5 for the HAV1 Repl. upstream and downstream sites respectively, and ~5.3-4.3 and 5.5-4.1 for the T4/5 upstream and downstream sites respectively), with a slight decrease in pH between June and July for HAV1 Repl., and June to August for T4/5, during the rainfall period is caused by organic humic/fulvic acids from decomposing fynbos vegetation entering the surface water systems through stormwater runoff. The tributary in the vicinity of the HAV1 Repl. site is likely slightly more acidic than the tributary near the T4/5 site for two reasons:
 - The catchment of the tributary in the vicinity of the HAV1 Repl. site is highly The HAV1 Repl. catchment is heavily invaded by Eucalyptus (Blue Gum), whose decomposing leaves further acidify surface water (with more Eucalyptus downstream resulting in lower downstream pH).
 - The T4/5 catchment includes extensive Gydo Formation (Bokkeveld Group) shales that produce clay-rich sediments buffering acidity, and vineyards where liming may raise pH as carbonates wash into the tributary
- The changes to pH observed at the HAV1 Repl. upstream on the 19th and 30th of June 2025 are likely due to the high rainfall experienced during the month (121 mm). Downstream had one minor exceedance of 4.46 on the 13th of August 2025 and was likely due to the 29.2 mm of rain received on the 9th of August 2025. Between the 30th of June and the 28th of August 2025, a decrease in pH was observed at the T4/5 upstream site likely due to the increase in rainfall observed between June and August (based on the HR weather station – see **Figure 2.3**). The pH at all sites returned to within 0.5 units from baseline following the completion of construction activities.
- EC and TDS at both HAV1 Repl. and T4/5 site showed clear seasonal and possible construction-related changes over the monitoring period. Surface water at both upstream sites remained relatively low in EC/TDS (~15–22 mS/m / ~120–180 mg/L at HAV1 Repl.; ~23–33 mS/m / ~180–240 mg/L at T4/5), whereas downstream surface water consistently exhibited higher EC/TDS values (~20–30 mS/m / ~130–300 mg/L at HAV1 Repl.; ~40–45 mS/m / ~250–300 mg/L at T4/5). The increase is likely due to reduced surface water flow leading to a build-up of salts in the surrounding area which are washed into the stream following the beginning of the wet season increasing the salts within the stream, these get diluted and decrease over time as the rain increases. This can also be caused by

increased clay-rich weathered sediment input from the Gydo Formation shales moving further downstream within both watercourse catchments. This also corresponds to active construction phases (pumphouse and trenching at T4/5) and may be related to suspended material from exposed soils flowing into the tributaries. A large spike in TDS on the 22nd of April 2025 is noted at both the upstream (1066 mg/L) and downstream (8743 mg/L) sampling sites at T4/5. There was no rainfall recorded in the two weeks leading up to this event and as such it is not known what the cause of the increase TDS is. As it occurred at both the upstream and downstream sites it is inferred that the cause may be due to activities taking place on the farm further upstream. A marked reduction in EC/TDS was observed across both upstream and downstream sites from June to August 2025, coinciding with the increase in rainfall (see **Figure 2-3**) and surface runoff diluted salt concentrations. By late August to September, conductivity and TDS values stabilised near or slightly below baseline levels, indicating effective hydrological flushing.

- Slight increases in TSS at short term intervals at both the HAV1 Repl. and T4/5 sites. Increases before the rainy season on can be attributed to extremely low flow and disturbance of the stream during sampling. Namely, 27.0 mg/L on the 14th of January 2025 and 10.00 mg/L on the 22nd of April 2025 at HAV1 Repl. upstream. 21 mg/L on the 23rd of March 2025 and the 13th of April 2025 at T4/5 Upstream and Downstream respectively. The spike in TSS (28 mg/L) at HAV1 Repl. Downstream on the 30th of June 2025 occurred following multiple rainfall events during June 2025 (see **Figure 2-3**). Elevated TSS at T4/5 between the 22nd of April and 30th of June 2025 (66.0-136.0 mg/L) upstream and (63.0-170.0 mg/L) downstream correlates with the start of the rainy season. Runoff from the surrounding area is expected increase to surface water flow leading to runoff of silt from the surrounding area which are washed into the stream following the beginning of the wet season increasing the salts within the stream, these get diluted and decrease over time as the rain increases. This can also be caused by to increased clay-rich weathered sediment input from the Gydo Formation shales moving further downstream within both watercourse catchments. This also corresponds to active construction phases (pumphouse and trenching at T4/5) and may be related to suspended material from exposed soils flowing into the tributaries. Following Construction TSS returned to undetectable limits at all sites with the exception of T4/5 Downstream on the 3rd of September 2025 which was 3 mg/L and relatable to the slightly raised EC and TDS mentioned above.
- Turbidity (Nephelometric Turbidity Units [NTU]) was highly variable across both upstream and downstream monitoring sites within both watercourses, and therefore there were no indications of construction impacts on turbidity. Some trends show turbidity decreased within the HAV1 Repl. downstream site (from ~10- NTU to ~2.3 NTU) following the reinstatement of flow on the 19th of May 2025, with a minor increase to 4.2 following the rainfall events in the final week of June 2025, likely due to the flushing of muddy pools from the watercourse. Turbidity varied greatly at T4/5 (1.5 – 66.5 NTU) upstream and (3.31-108.0 NTU) downstream showing no trends or indication of impacts from construction.
- Minor fats, oils and grease (0.7 and 1.3 mg/L) were observed at both the HAV1 Repl. upstream and downstream sites respectively on the 28th of August 2025. Levels at the T4/5 sites remained low throughout the monitoring period (0.6 – 1.7 mg/l) indicating minimal contamination from anthropogenic sources. One small increase was noted at both the upstream (2.4 mg/l) and downstream (1.6 mg/L) sites on the 28th of August 2025 which may be due to surface runoff carrying organic residues from surrounding agricultural activities into the tributary. All sites returned to baseline or near to baseline (0.7 mg/L at T4/5 Upstream) following the completion of construction.

The in-stream water quality results, therefore, indicate no definitive deterioration of Onrus River tributary watercourse quality during HAV1 Repl. and T4/5 construction activities.

Table 4-1 Macrochemical laboratory analysis results for the HAV1 Repl. upstream and downstream water quality monitoring sites for January -September 2025, in comparison to the 1996 SAWQG TWQR for aquatic ecosystems. Green highlighted results indicate constituents that do not meet the SAWQG TWQR for aquatic ecosystems, while red and orange highlighted sample dates indicate samples collected pre- and post-HAV1 Repl. construction activities respectively. Pink cells indicated with a * show that the site was dry and could not be sampled.

Chemical Constituent		HAV1 Repl. Upstream													
		14/01/2025	27/03/2025	10/04/2025	22/04/2025	08/05/2025	19/05/2025	05/06/2025	19/06/2025	30/06/2025	18/07/2025	31/07/2025	13/08/2025	28/08/2025	08/09/2025
	SAWQG TWQR	Baseline	Temporary closure	Pumphouse Construction	Temporary closure				Pumphouse Construction					Commissioning	
pH	>0.5 pH unit difference to baseline	5.00	4.86	4.88	4.84	4.70	4.53	4.61	4.48	4.46	4.56	4.64	4.64	4.68	4.69
Conductivity (mS/m)	>15% difference to baseline	15.00	15.60	15.60	16.30	20.90	19.60	21.10	22.40	21.10	17.00	17.00	15.70	15.80	15.80
Total Dissolved Solids (mg/L)	>15% difference to baseline	126.00	133.00	142.00	160.00	188.00	178.00	147.00	188.00	157.00	172.00	144.00	86.00	139.00	78.00
Total Suspended Solids (mg/L)	>10% difference to baseline	27.00	<2.00	<2.00	10.00	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00	<2.00
Turbidity (NTU)	-	0.71	0.58	0.52	1.75	0.39	0.50	0.50	0.60	1.07	1.06	1.27	0.63	3.12	1.00
Fats, oils, grease (mg/L)	-	<0.50	<0.50	<0.50	<0.50	0.50	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.70	0.50
Chemical Constituent		HAV1 Repl. Downstream													
		14/01/2025	27/03/2025	10/04/2025	22/04/2025	08/05/2025	19/05/2025	05/06/2025	19/06/2025	30/06/2025	18/07/2025	31/07/2025	13/08/2025	28/08/2025	08/09/2025
	SAWQG TWQR	Baseline	Temporary closure	Pumphouse Construction	Temporary closure				Pumphouse Construction					Commissioning	
pH	>0.5 pH unit difference to baseline	4.00	*	*	*	*	3.93	4.15	4.19	4.28	4.26	4.26	4.64	4.29	4.22
Conductivity (mS/m)	>15% difference to baseline	29.00	*	*	*	*	27.80	28.60	24.40	22.30	19.70	19.80	15.70	19.40	19.40
Total Dissolved Solids (mg/L)	>15% difference to baseline	175.00	*	*	*	*	172.00	163.00	170.00	266.00	127.00	332.00	86.00	135.00	90.00
Total Suspended Solids (mg/L)	>10% difference to baseline	<2.00	*	*	*	*	<2.00	<2.00	<2.00	28.00	<2.00	<2.00	<2.00	<2.00	<2.00
Turbidity (NTU)	-	2.72	*	*	*	*	9.92	2.31	0.63	4.20	1.53	2.44	0.63	1.89	2.89
Fats, oils, grease (mg/L)	-	<0.5	*	*	*	*	0.60	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	1.30	<0.50

*Monitoring site was dry and therefore unable to be monitored during this period.

Table 4-2 Macrochemical laboratory analysis results for the T4/5 upstream and downstream water quality monitoring sites for January-September 2025, in comparison to the 1996 SAWQG TWQR for aquatic ecosystems. Green highlighted results indicate constituents that do not meet the SAWQG TWQR for aquatic ecosystems, while red and orange highlighted sample dates indicate samples collected pre- and post-T4/5 construction activities respectively.

Chemical Constituent		T4/5 Upstream														
		16/02/2024	14/01/2025	27/03/2025	10/04/2025	22/04/2025	08/05/2025	19/05/2025	05/06/2025	19/06/2025	30/06/2025	18/07/2025	31/07/2025	13/08/2025	28/08/2025	08/09/2025
	SAWQG TWQR	Baseline		Pumphouse Construction				Trenching							Commissioning	
pH	>0.5 pH unit difference to baseline	5.39	6.00	5.29	4.87	5.20	5.25	5.11	5.31	5.03	4.68	4.30	4.83	4.38	4.68	4.96
Conductivity (mS/m)	>15% difference to baseline	23.00	25.00	28.90	16.60	30.30	33.00	33.20	33.10	33.40	36.50	23.10	27.60	20.80	22.10	24.50
Total Dissolved Solids (mg/L)	>15% difference to baseline	184.00	371.00	193.00	200.00	1066.00	183.00	241.00	228.00	237.00	315.00	222.00	311.00	115.00	178.00	157.00
Total Suspended Solids (mg/L)	>10% difference to baseline	<2.00	<2.00	21.00	<2.00	1130.00	136.00	<2.00	95.00	66.00	184.00	<2.00	<2.00	<2.00	<2.00	<2.00
Turbidity (NTU)	-	7.87	41.80	19.80	1.05	66.50	53.20	19.20	31.00	38.30	51.70	4.66	25.80	12.70	17.10	26.00
Fats, oils, grease (mg/L)	-	<0.50	0.60	<0.50	<0.50	<0.50	<0.50	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	1.70	2.40
		T4/5 Downstream														
Chemical Constituent		16/02/2024	14/01/2025	27/03/2025	10/04/2025	22/04/2025	08/05/2025	19/05/2025	05/06/2025	19/06/2025	30/06/2025	18/07/2025	21/07/2025	13/08/2025	28/08/2025	08/09/2025
		Baseline		Pumphouse Construction				Trenching							Commissioning	
pH	>0.5 pH unit difference to baseline	5.43	6.00	5.36	5.39	5.39	5.35	5.23	4.17	5.20	5.47	4.52	5.24	4.61	4.53	5.00
Conductivity (mS/m)	>15% difference to baseline	42.00	40.00	42.60	43.30	43.90	45.40	44.90	28.20	47.90	45.70	27.00	30.10	20.80	22.30	30.80
Total Dissolved Solids (mg/L)	>15% difference to baseline	263.00	254.00	252.00	398.00	8743.00	276.00	294.00	281.00	298.00	314.00	188.00	234.00	246.00	175.00	156.00
Total Suspended Solids (mg/L)	>10% difference to baseline	<2.00	13.00	<2.00	<2.00	63.00	<2.00	<2.00	<2.00	<2.00	170.00	<2.00	<2.00	<2.00	<2.00	3.00
Turbidity (NTU)	-	9.32	12.30	35.50	7.53	33.80	24.90	6.34	3.31	8.87	83.00	5.00	108.00	5.62	4.10	14.20
Fats, oils, grease (mg/L)	-	<0.50	0.70	<0.50	<0.50	<0.50	<0.50	<0.5	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	1.60	<0.50

4.2 Habitat Assessment

As stipulated in Appendix II Condition 4.2 of the Section 21(c) and (i) WUL, a habitat assessment of the affected watercourses was undertaken at the HAV1 Repl. and T4/5 upstream/downstream monitoring sites, and described below (see **Figure 3-2**, taken from FEN Consulting [2025a]):

- **HAV1 Repl. Upstream:** This closed-canopied seasonal mountain stream is a clear light brown colour, which is < 1 m wide and ~ 0.15 m deep. A slow, shallow run dominated the hydraulic biotope habitat, with occasional shallow pools observed. This stream has had its hydrological budget, marginal and vegetation composition significantly impacted by historic and ongoing *Eucalyptus* tree (Blue Gum) afforestation practices, and subsequent invasion by several *Acacia* (wattle) species. The dominant indigenous marginal vegetation was *Ficinia capillifolia*. Parts of the stream reach were buried underneath alien vegetation debris, and it is envisaged that continued alien invasive vegetation clearing (as observed) will increase the rainfall catchment yield available to this stream, which would increase the hydroperiod and ability of this stream to support a larger vegetation community in future. The water quality of this stream is considered good, despite organic input almost entirely from alien invasive vegetation. During the January 2025 assessment, the site was sampled, however, sampling was limited as the site was reduced to a small trickle of water of roughly 5 cm depth.
 - Habitat suitability at the HAV1 Repl. upstream site deteriorated from baseline (IHAS score: 60% in January 2024) to the post-construction period (IHAS score: 49% in September 2025), see **Table 4-3**. This decrease in habitat suitability is likely seasonally driven with lower base flows compared to the previous season.
- **HAV1 Repl. Downstream:** The overall vegetation community remained dominated by alien and invasive vegetation, and despite the erosion, the increased stream width (~ 1m), depth (~ 0.3 m) and discharge can accommodate a denser and more specious aquatic vegetation community (compared to the upstream site), as evidenced by species such as *Polypogon monspeliensis* (invasive), *Juncus* sp., *Ficinia capillifolia*, and *Carpha glomerata*.
 - Habitat suitability at the HAV1 Repl. downstream site deteriorated from baseline (IHAS score: 62% in January 2024) to post-construction period (IHAS score: 48% in September 2025), see **Table 4-3**. The decrease in habitat suitability is likely seasonally driven with lower base flows compared to the previous season.
- **T4/5 Upstream:** This river reach within a larger channelled valley bottom wetland had recently undergone large scale erosion, and as a result, much of the riverine habitat had been lost. The river further upstream was observed to be in a zero flow condition, and therefore, it is suspected that the discharge at this site is likely being supplemented by impoundment seepage or other lateral interflow processes. The stream active channel was ~1 m wide and < 0.1 m deep, was clear and dominated by sand and mud biotopes. The hydrology of the stream was a barely perceptible run. Disturbance of this river bed has allowed for the dominance by pioneering species such as *Pteridium aqualinum* (Bracken fern) and the water quality is considered good, although the water temperature is warmer and the clarity is more turbid than what it would be, compared to if the river was still vegetated.
 - Habitat suitability at the T4/5 upstream site improved from baseline (IHAS score: 43% in January 2024) to post-construction period (IHAS score: 51% in September 2025), see **Table 4-4**. The observed changes may be due to seasonal effects as well as the impact of fire on the system.

- **T4/5 Downstream:** This downstream river reach, by comparison, accommodated a much more diverse SASS5 sampling habitat consisting of runs, riffles, pools, and backwaters. Discharge at this site was significantly greater compared to the upstream site, with the river being ~ 1.5 m wide and 0.2 m deep. Although erosion was still very evident at this site, the marginal vegetation out of current was still intact, which provided a good SASS5 vegetation sampling habitat. Visually, the water quality improved significantly at this site and was a clear light brown colour, and is considered to be of a very good quality. As with previous assessments, the hydraulic biotopes were regarded as good. Cobbles at the site become increasingly covered with organic silt, which is likely due to a general decrease in baseflows over the summer season.
 - Habitat suitability at the T4/5 downstream site deteriorated from the pre-construction (IHAS: 80% in January 2024) to the post-construction period (IHAS score: 68% in September 2025), see **Table 4-4**. This decrease in habitat suitability is likely seasonally driven with lower base flows compared to the previous season.

4.3 SASS5 Bio-Monitoring

This section provides a summary of the SASS5 bio-monitoring results undertaken at the HAV1 Repl. and T4/5 upstream/downstream sites during January 2025, April 2025, May 2025, June 2025 and September 2025, compared to the January 2024 baseline (see **Table 4-3** and **Table 4-4**). January 2024 data was used as the baseline, as this sampling was undertaken before borehole drilling/ testing (2024) and subsequent pipeline and pumphouse construction (2025) commenced. For a more in-depth discussion of these results, refer to the larger, all-encompassing SASS5 bio-monitoring reports prepared for Umvoto by FEN Consulting (2025a-c) in **Appendix B**.

The HAV1 Repl. upstream site's ecological condition remained constant at a PES Class A (Natural) between January 2024 and September 2025, with similar SASS5 and ASPT scores observed (see **Table 4-3**). The HAV1 Repl. downstream site improved substantially from a PES Class E/F (Severely to Critically Modified) in January 2024 to a PES Class B (Largely Natural) ecological condition in September 2025 due to a large increase in SASS5 and ASPT scores (see **Table 4-3**). The improved community diversity and sensitivity at the downstream site can be ascribed to improved flow.

The T4/5 upstream site's ecological condition improved from a PES Class E/F (Severely to Critically Modified) to a PES Class D (Largely Modified) between the January 2024 and September 2025 assessments, likely due to the significantly increasing SASS5 score and slightly increasing ASPT scores. The T4/5 downstream site deteriorated from a PES Class C (Moderately Modified) to a PES Class D (Largely Modified) ecological condition between January 2024 and September 2025 assessment, likely due to decreasing SASS5 and ASPT scores (see **Table 4-4**).

Concerns are raised with respect to significantly decreasing SASS5 and ASPT scores for the T4/5 downstream site compared to the January 2024 assessment. However, the deterioration in macro-invertebrate community integrity is most likely due to significantly decreased habitat suitability and low flow. Further, given the very high erosive damage in the Hemel en Aarde catchment in general, caused by the end-September 2023 flood event (>150 mm rainfall occurring on the 24th September 2023), this is regarded as being outside of their normal biotic conditions, both from a habitat quality and water quality perspective. No points of concern are raised with respect to the macro-invertebrate community and the associated habitat following construction of the pumphouse and pipelines for the HAV1 Repl. borehole as ecological conditions returned to baseline.

Table 4-3

SASS5 bio-monitoring results for the HAV1 Repl. upstream and downstream sites assessed on the 14th January 2025 (pre-HAV1 Repl. pumphouse and pipeline construction), 3rd of April 2025, 5th of May 2025, 22nd May 2025, 30th June 2025 (during HAV1 Repl. pumphouse and pipeline construction) and September 2025 (post-HAV1 Repl. pumphouse and pipeline construction). SASS5 scores are used to derive the PES of the Onrus River tributary passing the HAV1 Repl. borehole, with Class A (Pristine) highlighted in blue, Class B (Largely Natural) highlighted in green, Class C (Moderately Modified) in yellow, Class D (Largely Modified) in orange and Class E/F (Severely to Critically Modified) in red.

SASS5 Items	HAV1 Repl. Upstream						
	19/01/2024	14/01/2025	03/04/2025	05/05/2025	22/05/2025	30/06/2025	03/09/2025
SASS5 Total Score	76	73	59	70	66	80	71
Number of Taxa	9	10	9	10	8	10	8
ASPT	8.44	7.3	6.56	7.00	8.25	8.00	8.88
PES	A	B/C	C	C	B	A	A
IHAS	60	39	34	50	50	56	49
SASS5 Items	HAV1 Repl. Downstream						
	19/01/2024	14/01/2025	03/04/2025	05/05/2025	22/05/2025	30/06/2025	03/09/2025
SASS5 Total Score	24	42	n/a*	n/a*	n/a*	22	56
Number of Taxa	6	7	n/a*	n/a*	n/a*	3	7
ASPT	4	6	n/a*	n/a*	n/a*	7.33	8.00
PES	E/F	D	n/a*	n/a*	n/a*	A/B	B
IHAS	62	46	n/a*	n/a*	n/a*	39	48

*Monitoring site was dry and therefore unable to be assessed during this period.

Table 4-4

SASS5 bio-monitoring results for the T4/5 upstream and downstream sites assessed on the 14th January 2025 (pre-T4/5 pumphouse and pipeline construction), 3rd of April 2025, 5th of May 2025, 22nd May 2025 (during T4/5 pumphouse and pipeline construction) and September 2025 (post-T4/5 pumphouse and pipeline construction). SASS5 scores are used to derive the PES of the Onrus River tributary river passing the T4/5 borehole, Class C (Moderately Modified) in yellow, Class D (Largely Modified) in orange, and Class E/F (Severely to Critically Modified) in red.

SASS5 Items	T4/5 Upstream						
	19/01/2024	14/01/2025	03/04/2025	05/05/2025	22/05/2025	30/06/2025	03/09/2025
SASS5 Total Score	47	49	46	67	25	54	94
Number of Taxa	10	9	11	14	6	10	15
ASPT	4.70	5.44	4.18	4.79	4.17	5.40	6.27
PES	E/F	D	E/F	E/F	E/F	D	D
IHAS	43	39	34	47	44	48	51
SASS5 Items	T4/5 Downstream						
	19/01/2024	14/01/2025	03/04/2025	05/05/2025	22/05/2025	30/06/2025	03/09/2025
SASS5 Total Score	114	85	79	71	61	87	53
Number of Taxa	23	17	16	13	11	15	10
ASPT	4.96	5	4.94	5.46	5.55	5.80	5.30
PES	C	D	D	D	D	D	D
IHAS	80	37	50	60	62	70	68

5. CONCLUSIONS

In-stream water quality monitoring and SASS5 bio-monitoring were successfully completed within Onrus River tributaries in the vicinity of the HAV1 Repl. and T4/5 boreholes, at monitoring sites both upstream and downstream of pipeline and pumphouse construction activities between January and September 2025.

Both streams are naturally acidic, and pH results across all HAV1 Repl. and T4/5 sites generally remained within 0.5 units of baseline after construction, with seasonal decreases likely due to winter rainfall and surrounding geology. EC, TDS, and TSS showed predictable seasonal patterns, with higher values before the rainy season and dilution during increased winter flows, while one unexplained increase in TDS at T4/5 in April was likely due to upstream farm activities. Construction-related influences were minimal, with temporary increases in TSS near the start of the rainy season corresponding to trenching and runoff, but all sites returned to low or undetectable levels after construction. Turbidity remained highly variable at all sites with no clear construction-related trends. Minor fats, oils and grease detections occurred late in the monitoring period but returned to baseline, indicating limited construction related contamination; overall, no definitive deterioration of water quality was observed during the construction at both sites.

The September 2025 (post-construction) assessment showed improvement in macroinvertebrate community diversity (SASS5 and ASPT scores) at the HAV1 Repl. upstream site (PES: A for January 2024 and September 2025), HAV1 Repl. downstream site (PES: E/F for January 2024 and PES: B for September 2025) and T4/5 upstream site (PES: E/F for January 2024 and PES: D for September 2025) and a slight deterioration at T4/5 downstream (PES: C for January 2024 and PES: D for September 2025). Habitat suitability (IHAS) across sites generally decreased compared to the baseline, which is likely due to seasonal variation in flow and, therefore largely natural.

Concerns are raised with respect to significantly decreasing SASS5 and ASPT scores for the T4/5 downstream site compared to the January 2024 assessment. However, the deterioration in macro-invertebrate community integrity is most likely due to significantly decreased habitat suitability and low flow. Further, given the very high erosive damage in the Hemel en Aarde catchment in general, caused by the end-September 2023 flood event (>150 mm rainfall occurring on the 24th September 2023), this is regarded as being outside of their normal biotic conditions, both from a habitat quality and water quality perspective. No points of concern are raised with respect to the macro-invertebrate community and the associated habitat following construction of the pumphouse and pipelines for the HAV1 Repl. borehole as ecological conditions returned to baseline. Based on these observations, it is recommended that bi-annual monitoring be continued at the T4/5 site to determine whether baseline conditions are restored.

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APPENDIX A – HAV1 Repl. and T4/5

Integral Laboratories Hydrochemical Results Sheets

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Service Request Number: PW-2025-48479
Date of Certificate: 30-January-2025
Date Completed: 30-January-2025
Date of Sampling: 14-January-2025
Date of Reveal at Lab: 21-January-2025

Contact: Patrick Robinson

Sample Identification:					
T4/5 Upstream					
Sample Number:	PW-25-161890	Sampling Time:	N/A	Sample Condition:	Room Temperature
Remark:					
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		25.0	2025-01-22
pH @ 25°C	M6	pH units		6.00	2025-01-22
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		371	2025-01-28
Total Suspended Solids	M8	mg/L		<2.00	2025-01-28
Turbidity	M12	NTU		41.8	2025-01-22
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		0.60	2025-01-27

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Date of Certificate: 30-January-2025
Date Completed: 30-January-2025
Date of Sampling: 14-January-2025
Date of Receiving at Lab: 21-January-2025

Contact: Patrick Robinson

Sample Identification:					
T4/5 Downstream					
Sample Number:	PW-25-161891	Sampling Time:	N/A	Sample Condition:	Room Temperature
Remark:					
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		40.0	2025-01-22
pH @ 25°C	M6	pH units		6.00	2025-01-22
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		254	2025-01-28
Total Suspended Solids	M8	mg/L		13.0	2025-01-28
Turbidity	M12	NTU		12.3	2025-01-22
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		0.70	2025-01-27

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Date of Sampling: 14-January-2025
Date of Receiving at Lab: 21-January-2025

Contact: Patrick Robinson

Sample Identification:		HAV1 Repl. Upstream			
Sample Number:	PW-25-161892	Sampling Time:	N/A	Sample Condition:	Room Temperature
				Remark:	
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		15.0	2025-01-22
pH @ 25°C	M6	pH units		5.00	2025-01-22
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		126	2025-01-28
Total Suspended Solids	M8	mg/L		27.0	2025-01-28
Turbidity	M12	NTU		0.71	2025-01-22
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-01-27

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Date Completed: 30-January-2025
Date of Sampling: 14-January-2025
Date of Receiving at Lab: 21-January-2025

Contact: Patrick Robinson

Sample Identification:					
HAV1 Repl. Downstream					
Sample Number:	PW-25-161893	Sampling Time:	N/A	Sample Condition:	Room Temperature
Remark:					
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		29.0	2025-01-22
pH @ 25°C	M6	pH units		4.00	2025-01-22
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		175	2025-01-28
Total Suspended Solids	M8	mg/L		<2.00	2025-01-28
Turbidity	M12	NTU		2.72	2025-01-22
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-01-27

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	Hermanus	Date Completed:	30-January-2025
	7200	Date of Sampling:	14-January-2025
Contact:	Patrick Robinson	Date of Receival at Lab:	21-January-2025

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	Hermanus	Date Completed:	08-April-2025
	7200	Date of Sampling:	27-March-2025
Contact:	Patrick Robinson	Date of Receival at Lab:	28-March-2025

Sample Identification: T4/5 Upstream					
Sample Number:	PW-25-166078	Sampling Time:	N/A	Sample Condition:	Please Select
Remark:					
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		28.9	2025-04-01
pH @ 25°C	M6	pH units		5.29	2025-04-01
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		193	2025-04-08
Total Suspended Solids	M8	mg/L		21.0	2025-04-03
Turbidity	M12	NTU		19.8	2025-04-01
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-04-02

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	Hermanus	Date Completed:	08-April-2025
	7200	Date of Sampling:	27-March-2025
Contact:	Patrick Robinson	Date of Receival at Lab:	28-March-2025

Sample Identification: T4/5 Downstream					
Sample Number:	PW-25-166079	Sampling Time:	N/A	Sample Condition:	Remark:
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		42.6	2025-04-01
pH @ 25°C	M6	pH units		5.36	2025-04-01
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		252	2025-04-08
Total Suspended Solids	M8	mg/L		<2.00	2025-04-03
Turbidity	M12	NTU		35.5	2025-04-01
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-04-02

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	Hermanus	Date Completed:	08-April-2025
	7200	Date of Sampling:	27-March-2025
Contact:	Patrick Robinson	Date of Receival at Lab:	28-March-2025

Sample Identification:					
HAV1 Repl. Upstream					
Sample Number:	PW-25-166080	Sampling Time:	N/A	Sample Condition:	Remark:
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		15.6	2025-04-01
pH @ 25°C	M6	pH units		4.86	2025-04-01
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		133	2025-04-08
Total Suspended Solids	M8	mg/L		<2.00	2025-04-03
Turbidity	M12	NTU		0.58	2025-04-01
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-04-02

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		Date Completed:	08-April-2025
		Date of Sampling:	27-March-2025
Contact:	Patrick Robinson	Date of Reveal at Lab:	28-March-2025

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Email: westerncape@integrallabs.co.za

T0417

Certificate Of Analysis

Company: Overstrand Munisipaliteit (Umvoto)
Address: Magnolia Street
Hermanus
7200

Service Request Number: PW-2025-50004
Date of Certificate: 29-April-2025
Date Completed: 29-April-2025
Date of Sampling: 10-April-2025
Date of Receiving at Lab: 11-April-2025

Contact: Patrick Robinson

Sample Identification:					
T4/5 Upstream					
Sample Number:	PW-25-166879	Sampling Time:	N/A	Sample Condition:	Remark:
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		16.6	2025-04-14
pH @ 25°C	M6	pH units		4.87	2025-04-14
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		200	2025-04-25
Total Suspended Solids	M8	mg/L		<2.00	2025-04-25
Turbidity	M12	NTU		1.05	2025-04-14
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-04-15

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Company: Overstrand Munisipaliteit (Umvoto)
Address: Magnolia Street
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Service Request Number: PW-2025-50004
Date of Certificate: 29-April-2025
Date Completed: 29-April-2025
Date of Sampling: 10-April-2025
Date of Receiving at Lab: 11-April-2025

Contact: Patrick Robinson

Sample Identification:					
T4/5 Downstream					
Sample Number:	PW-25-166880	Sampling Time:	N/A	Sample Condition:	Remark:
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		43.3	2025-04-14
pH @ 25°C	M6	pH units		5.39	2025-04-14
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		398	2025-04-25
Total Suspended Solids	M8	mg/L		<2.00	2025-04-25
Turbidity	M12	NTU		7.53	2025-04-14
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-04-15

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Service Request Number: PW-2025-50004
Date of Certificate: 29-April-2025
Date Completed: 29-April-2025
Date of Sampling: 10-April-2025
Date of Receiving at Lab: 11-April-2025

Contact: Patrick Robinson

Sample Identification:					
HAV1 Repl.Upstream					
Sample Number:	PW-25-166881	Sampling Time:	N/A	Sample Condition:	Remark:
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		15.6	2025-04-14
pH @ 25°C	M6	pH units		4.88	2025-04-14
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		142	2025-04-25
Total Suspended Solids	M8	mg/L		<2.00	2025-04-25
Turbidity	M12	NTU		0.52	2025-04-14
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-04-15

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Certificate Of Analysis

Company:	Overstrand Munisipaliteit (Umvoto)	Service Request Number:	PW-2025-50004
Address:	Magnolia Street Hermanus 7200	Date of Certificate:	29-April-2025
		Date Completed:	29-April-2025
		Date of Sampling:	10-April-2025
Contact:	Patrick Robinson	Date of Receival at Lab:	11-April-2025

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Certificate Of Analysis

Company:	Overstrand Munisipaliteit (Umvoto)	Service Request Number:	PW-2025-50164
Address:	Magnolia Street	Date of Certificate:	06-May-2025
	Hermanus	Date Completed:	06-May-2025
	7200	Date of Sampling:	22-April-2025
Contact:	Patrick Robinson	Date of Receiving at Lab:	23-April-2025

Sample Identification:					
T4/5 Upstream					
Sample Number:	PW-25-167420	Sampling Time:	N/A	Sample Condition:	Please Select
Remark:					
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		30.3	2025-04-25
pH @ 25°C	M6	pH units		5.20	2025-04-25
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		1066	2025-04-25
Total Suspended Solids	M8	mg/L		1130	2025-05-02
Turbidity	M12	NTU		66.5	2025-04-24
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-04-24

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Certificate Of Analysis

Company:	Overstrand Munisipaliteit (Umvoto)	Service Request Number:	PW-2025-50164
Address:	Magnolia Street	Date of Certificate:	06-May-2025
	Hermanus	Date Completed:	06-May-2025
	7200	Date of Sampling:	22-April-2025
Contact:	Patrick Robinson	Date of Receival at Lab:	23-April-2025

Sample Identification: T4/5 Downstream					
Sample Number:	PW-25-167421	Sampling Time:	N/A	Sample Condition:	Remark:
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		43.9	2025-04-25
pH @ 25°C	M6	pH units		5.39	2025-04-25
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		8743	2025-04-25
Total Suspended Solids	M8	mg/L		63.0	2025-05-02
Turbidity	M12	NTU		33.8	2025-04-24
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-04-24

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Date of Certificate: 06-May-2025
Date Completed: 06-May-2025
Date of Sampling: 22-April-2025
Date of Receiving at Lab: 23-April-2025

Contact: Patrick Robinson

Sample Identification: HAV1 REPL.Upstream					
Sample Number: PW-25-167422	Sampling Time: N/A		Sample Condition:		Remark:
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		16.3	2025-04-25
pH @ 25°C	M6	pH units		4.84	2025-04-25
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		160	2025-04-25
Total Suspended Solids	M8	mg/L		10.0	2025-05-02
Turbidity	M12	NTU		1.75	2025-04-24
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-04-24

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Address:	Magnolia Street	Date of Certificate:	06-May-2025
	Hermanus	Date Completed:	06-May-2025
	7200	Date of Sampling:	22-April-2025
Contact:	Patrick Robinson	Date of Receival at Lab:	23-April-2025

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Certificate Of Analysis

Company: Overstrand Munisipaliteit (Umvoto)
Address: Magnolia Street
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Service Request Number: PW-2025-50465
Date of Certificate: 23-May-2025
Date Completed: 23-May-2025
Date of Sampling: 08-May-2025
Date of Receiving at Lab: 12-May-2025

Contact: Patrick Robinson

Sample Identification: T4/5 Upstream					
Sample Number: PW-25-168694	Sampling Time: N/A		Sample Condition: Please Select	Remark:	
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		33.0	2025-05-16
pH @ 25°C	M6	pH units		5.25	2025-05-16
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		183	2025-05-23
Total Suspended Solids	M8	mg/L		136	2025-05-23
Turbidity	M12	NTU		53.2	2025-05-16
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-05-16

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Service Request Number: PW-2025-50465
Date of Certificate: 23-May-2025
Date Completed: 23-May-2025
Date of Sampling: 08-May-2025
Date of Reveal at Lab: 12-May-2025

Contact: Patrick Robinson

Sample Identification:					
T4/5 Downstream					
Sample Number:	PW-25-168695	Sampling Time:	N/A	Sample Condition:	Remark:
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		45.4	2025-05-16
pH @ 25°C	M6	pH units		5.35	2025-05-16
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		276	2025-05-23
Total Suspended Solids	M8	mg/L		<2.00	2025-05-23
Turbidity	M12	NTU		24.9	2025-05-16
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-05-16

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Address:	Magnolia Street	Date of Certificate:	23-May-2025
	Hermanus	Date Completed:	23-May-2025
	7200	Date of Sampling:	08-May-2025
Contact:	Patrick Robinson	Date of Reveal at Lab:	12-May-2025

Sample Identification:					
HAV1 Repl. Upstream					
Sample Number:	PW-25-168696	Sampling Time:	N/A	Sample Condition:	Remark:
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		20.9	2025-05-16
pH @ 25°C	M6	pH units		4.70	2025-05-16
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		188	2025-05-23
Total Suspended Solids	M8	mg/L		<2.00	2025-05-23
Turbidity	M12	NTU		0.39	2025-05-16
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		0.50	2025-05-16

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Address:	Magnolia Street	Date of Certificate:	23-May-2025
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	7200	Date of Sampling:	08-May-2025
Contact:	Patrick Robinson	Date of Receival at Lab:	12-May-2025

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Certificate Of Analysis

Company:	Overstrand Munisipaliteit (Umvoto)	Service Request Number:	PW-2025-50595
Address:	Magnolia Street	Date of Certificate:	04-June-2025
	Hermanus	Date Completed:	04-June-2025
	7200	Date of Sampling:	19-May-2025
Contact:	Patrick Robinson	Date of Receiving at Lab:	20-May-2025

Sample Identification:					
T4/5 Upstream					
Sample Number:	PW-25-169223	Sampling Time:	N/A	Sample Condition:	Please Select
Remark:					
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		33.2	2025-05-26
pH @ 25°C	M6	pH units		5.11	2025-05-26
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		241	2025-06-03
Total Suspended Solids	M8	mg/L		<2.00	2025-05-29
Turbidity	M12	NTU		19.2	2025-05-22
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-05-29

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	Hermanus	Date Completed:	04-June-2025
	7200	Date of Sampling:	19-May-2025
Contact:	Patrick Robinson	Date of Receiving at Lab:	20-May-2025

Sample Identification:					
T4/5 Downstream					
Sample Number:	PW-25-169224	Sampling Time:	N/A	Sample Condition:	Remark:
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		44.9	2025-05-26
pH @ 25°C	M6	pH units		5.23	2025-05-26
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		294	2025-06-03
Total Suspended Solids	M8	mg/L		<2.00	2025-05-29
Turbidity	M12	NTU		6.34	2025-05-22
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-05-29

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	7200	Date of Sampling:	19-May-2025
Contact:	Patrick Robinson	Date of Reveal at Lab:	20-May-2025

Sample Identification:					
HAV1 Repl. Upstream					
Sample Number:	PW-25-169225	Sampling Time:	N/A	Sample Condition:	Remark:
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		19.6	2025-05-26
pH @ 25°C	M6	pH units		4.53	2025-05-26
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		178	2025-06-03
Total Suspended Solids	M8	mg/L		<2.00	2025-05-29
Turbidity	M12	NTU		0.50	2025-05-22
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-05-29

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	7200	Date of Sampling:	19-May-2025
Contact:	Patrick Robinson	Date of Reveal at Lab:	20-May-2025

Sample Identification:					
HAV1 Repl. Downstream					
Sample Number:	PW-25-169226	Sampling Time:	N/A	Sample Condition:	Remark:
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		27.8	2025-05-26
pH @ 25°C	M6	pH units		3.93	2025-05-26
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		172	2025-06-03
Total Suspended Solids	M8	mg/L		<2.00	2025-05-29
Turbidity	M12	NTU		9.92	2025-05-22
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		0.60	2025-05-29

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Address:	Magnolia Street Hermanus 7200	Date of Certificate:	04-June-2025
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		Date of Sampling:	19-May-2025
Contact:	Patrick Robinson	Date of Receival at Lab:	20-May-2025

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Tel: 021 863 1238 Fax: 086 635 8874
Email: westerncape@integrallabs.co.za

T0417

Certificate Of Analysis

Company: Overstrand Munisipaliteit (Umvoto)
Address: Magnolia Street
Hermanus
7200

Service Request Number: PW-2025-50909
Date of Certificate: 19-June-2025
Date Completed: 19-June-2025
Date of Sampling: Not supplied
Date of Receiving at Lab: 06-June-2025

Contact: Patrick Robinson

Sample Identification:		T4/5 Upstream			
Sample Number:	PW-25-170322	Sampling Time: N/A	Sample Condition:	Please Select	Remark:
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		33.1	2025-06-10
pH @ 25°C	M6	pH units		5.31	2025-06-10
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		228	2025-06-11
Total Suspended Solids	M8	mg/L		95.0	2025-06-19
Turbidity	M12	NTU		31.0	2025-06-10
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-06-12

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Certificate Of Analysis

Company: Overstrand Munisipaliteit (Umvoto)
Address: Magnolia Street
Hermanus
7200

Service Request Number: PW-2025-50909
Date of Certificate: 19-June-2025
Date Completed: 19-June-2025
Date of Sampling: Not supplied
Date of Receiving at Lab: 06-June-2025

Contact: Patrick Robinson

Sample Identification:					
T4/5 Downstream					
Sample Number:	PW-25-170323	Sampling Time:	N/A	Sample Condition:	Remark:
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		28.2	2025-06-10
pH @ 25°C	M6	pH units		4.17	2025-06-10
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		281	2025-06-11
Total Suspended Solids	M8	mg/L		<2.00	2025-06-19
Turbidity	M12	NTU		3.31	2025-06-10
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-06-12

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Address:	Magnolia Street	Date of Certificate:	19-June-2025
	Hermanus	Date Completed:	19-June-2025
	7200	Date of Sampling:	Not supplied
Contact:	Patrick Robinson	Date of Receiving at Lab:	06-June-2025

Sample Identification:					
HAV1 Repl. Upstream					
Sample Number:	PW-25-170324	Sampling Time:	N/A	Sample Condition:	Remark:
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		21.1	2025-06-10
pH @ 25°C	M6	pH units		4.61	2025-06-10
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		147	2025-06-11
Total Suspended Solids	M8	mg/L		<2.00	2025-06-19
Turbidity	M12	NTU		0.50	2025-06-10
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-06-12

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Company:	Overstrand Munisipaliteit (Umvoto)	Service Request Number:	PW-2025-50909
Address:	Magnolia Street	Date of Certificate:	19-June-2025
	Hermanus	Date Completed:	19-June-2025
	7200	Date of Sampling:	Not supplied
Contact:	Patrick Robinson	Date of Receiving at Lab:	06-June-2025

Sample Identification:					
HAV1 Repl. Downstream					
Sample Number:	PW-25-170325	Sampling Time:	N/A	Sample Condition:	Remark:
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		28.6	2025-06-10
pH @ 25°C	M6	pH units		4.15	2025-06-10
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		163	2025-06-11
Total Suspended Solids	M8	mg/L		<2.00	2025-06-19
Turbidity	M12	NTU		2.31	2025-06-10
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-06-12

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Company:	Overstrand Munisipaliteit (Umvoto)	Service Request Number:	PW-2025-50909
Address:	Magnolia Street	Date of Certificate:	19-June-2025
	Hermanus	Date Completed:	19-June-2025
	7200	Date of Sampling:	Not supplied
Contact:	Patrick Robinson	Date of Receival at Lab:	06-June-2025

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Certificate Of Analysis

Company: Overstrand Munisipaliteit (Umvoto)
Address: Magnolia Street
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7200

Service Request Number: PW-2025-51078
Date of Certificate: 01-July-2025
Date Completed: 01-July-2025
Date of Sampling: 19-June-2025
Date of Reveal at Lab: 20-June-2025

Contact: Patrick Robinson

Sample Identification:					
T4/5 Upstream					
Sample Number:	PW-25-170967	Sampling Time:	N/A	Sample Condition:	Chilled
Remark:					
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		33.4	2025-06-24
pH @ 25°C	M6	pH units		5.03	2025-06-24
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		237	2025-06-25
Total Suspended Solids	M8	mg/L		66.0	2025-06-27
Turbidity	M12	NTU		38.3	2025-06-25
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-06-27

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Company:	Overstrand Munisipaliteit (Umvoto)	Service Request Number:	PW-2025-51078
Address:	Magnolia Street	Date of Certificate:	01-July-2025
	Hermanus	Date Completed:	01-July-2025
	7200	Date of Sampling:	19-June-2025
Contact:	Patrick Robinson	Date of Receiving at Lab:	20-June-2025

Sample Identification:					
T4/5 Downstream					
Sample Number:	PW-25-170968	Sampling Time:	N/A	Sample Condition:	Chilled
				Remark:	
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		47.9	2025-06-24
pH @ 25°C	M6	pH units		5.20	2025-06-24
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		298	2025-06-25
Total Suspended Solids	M8	mg/L		<2.00	2025-06-27
Turbidity	M12	NTU		8.87	2025-06-25
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-06-27

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	Hermanus	Date Completed:	01-July-2025
	7200	Date of Sampling:	19-June-2025
Contact:	Patrick Robinson	Date of Receiving at Lab:	20-June-2025

Sample Identification:					
HAV1 Repl. Upstream					
Sample Number:	PW-25-170969	Sampling Time:	N/A	Sample Condition:	Chilled
Remark:					
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		22.4	2025-06-24
pH @ 25°C	M6	pH units		4.48	2025-06-24
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		188	2025-06-25
Total Suspended Solids	M8	mg/L		<2.00	2025-06-27
Turbidity	M12	NTU		0.60	2025-06-25
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-06-27

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Address:	Magnolia Street	Date of Certificate:	01-July-2025
	Hermanus	Date Completed:	01-July-2025
	7200	Date of Sampling:	19-June-2025
Contact:	Patrick Robinson	Date of Receiving at Lab:	20-June-2025

Sample Identification:					
HAV1 Repl. Downstream					
Sample Number:	PW-25-170970	Sampling Time:	N/A	Sample Condition:	Chilled
				Remark:	
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		24.4	2025-06-24
pH @ 25°C	M6	pH units		4.19	2025-06-24
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		170	2025-06-25
Total Suspended Solids	M8	mg/L		<2.00	2025-06-27
Turbidity	M12	NTU		0.63	2025-06-25
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-06-27

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Address:	Magnolia Street Hermanus 7200	Date of Certificate:	01-July-2025
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		Date of Sampling:	19-June-2025
Contact:	Patrick Robinson	Date of Receival at Lab:	20-June-2025

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Certificate Of Analysis

Company:	Overstrand Munisipaliteit (Umvoto)	Service Request Number:	PW-2025-51255
Address:	Magnolia Street	Date of Certificate:	11-July-2025
	Hermanus	Date Completed:	11-July-2025
	7200	Date of Sampling:	30-June-2025
Contact:	Patrick Robinson	Date of Reveal at Lab:	01-July-2025

Sample Identification:					
T4/5 Upstream					
Sample Number:	PW-25-171534	Sampling Time:	N/A	Sample Condition:	Chilled
Remark:					
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		36.5	2025-07-04
pH @ 25°C	M6	pH units		4.68	2025-07-04
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		315	2025-07-10
Total Suspended Solids	M8	mg/L		184	2025-07-11
Turbidity	M12	NTU		51.7	2025-07-02
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-07-04

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Service Request Number: PW-2025-51255
Date of Certificate: 11-July-2025
Date Completed: 11-July-2025
Date of Sampling: 30-June-2025
Date of Reveal at Lab: 01-July-2025

Contact: Patrick Robinson

Sample Identification:					
T4/5 Downstream					
Sample Number:	PW-25-171535	Sampling Time:	N/A	Sample Condition:	Chilled
Remark:					
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		45.7	2025-07-04
pH @ 25°C	M6	pH units		5.47	2025-07-04
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		314	2025-07-10
Total Suspended Solids	M8	mg/L		170	2025-07-11
Turbidity	M12	NTU		83.0	2025-07-02
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-07-04

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Service Request Number: PW-2025-51255
Date of Certificate: 11-July-2025
Date Completed: 11-July-2025
Date of Sampling: 30-June-2025
Date of Receiving at Lab: 01-July-2025

Contact: Patrick Robinson

Sample Identification:		HAV1 Repl. Upstream			
Sample Number:	PW-25-171536	Sampling Time:	N/A	Sample Condition:	Chilled
				Remark:	
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		21.1	2025-07-04
pH @ 25°C	M6	pH units		4.46	2025-07-04
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		157	2025-07-10
Total Suspended Solids	M8	mg/L		<2.00	2025-07-11
Turbidity	M12	NTU		1.07	2025-07-02
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-07-04

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Date Completed: 11-July-2025
Date of Sampling: 30-June-2025
Date of Receiving at Lab: 01-July-2025

Contact: Patrick Robinson

Sample Identification:					
HAV1 Repl. Downstream					
Sample Number:	PW-25-171537	Sampling Time:	N/A	Sample Condition:	Chilled
				Remark:	
Physical / Aesthetic Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		22.3	2025-07-04
pH @ 25°C	M6	pH units		4.28	2025-07-04
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		266	2025-07-10
Total Suspended Solids	M8	mg/L		28.0	2025-07-11
Turbidity	M12	NTU		4.20	2025-07-02
Organic Parameters	Method	Unit	Limit	Result	Analysis Date
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-07-04

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Address:	Magnolia Street Hermanus 7200	Date of Certificate:	11-July-2025
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		Date of Sampling:	30-June-2025
Contact:	Patrick Robinson	Date of Receival at Lab:	01-July-2025

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Certificate Of Analysis

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Address: Magnolia Street
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Service Request Number: PW-2025-51626
Date of Certificate: 07-August-2025
Date Completed: 07-August-2025
Date of Sampling: 18-July-2025
Date of Receival at Lab: 21-July-2025

Contact: Patrick Robinson

Sample Identification:					
T4/5 Upstream					
Sample Number:	PW-25-172759	Sampling Time:	N/A	Sample Condition:	Chilled
Remark:					
Physiochemical Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		23.1	2025-07-25
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-07-22
pH @ 25°C	M6	pH units		4.30	2025-07-25
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		222	2025-07-29
Total Suspended Solids	M8	mg/L		<2.00	2025-07-28
Turbidity	M12	NTU		4.66	2025-07-23

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Address: Magnolia Street
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Service Request Number: PW-2025-51626
Date of Certificate: 07-August-2025
Date Completed: 07-August-2025
Date of Sampling: 18-July-2025
Date of Receival at Lab: 21-July-2025

Contact: Patrick Robinson

Sample Identification:					
T4/5 Downstream					
Sample Number:	PW-25-172760	Sampling Time:	N/A	Sample Condition:	Chilled
Remark:					
Physiochemical Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		27.0	2025-07-25
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-07-22
pH @ 25°C	M6	pH units		4.52	2025-07-25
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		188	2025-07-29
Total Suspended Solids	M8	mg/L		<2.00	2025-07-28
Turbidity	M12	NTU		5.00	2025-07-23

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7200

Service Request Number: PW-2025-51626
Date of Certificate: 07-August-2025
Date Completed: 07-August-2025
Date of Sampling: 18-July-2025
Date of Receival at Lab: 21-July-2025

Contact: Patrick Robinson

Sample Identification:		HAV1 Repl. Upstream			
Sample Number:	PW-25-172761	Sampling Time: N/A	Sample Condition:	Chilled	Remark:
Physiochemical Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		17.0	2025-07-25
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-07-22
pH @ 25°C	M6	pH units		4.56	2025-07-25
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		172	2025-07-29
Total Suspended Solids	M8	mg/L		<2.00	2025-07-28
Turbidity	M12	NTU		1.06	2025-07-23

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Certificate Of Analysis

Company: Overstrand Munisipaliteit (Umvoto)
Address: Magnolia Street
Hermanus
7200

Service Request Number: PW-2025-51626
Date of Certificate: 07-August-2025
Date Completed: 07-August-2025
Date of Sampling: 18-July-2025
Date of Receival at Lab: 21-July-2025

Contact: Patrick Robinson

Sample Identification:					
HAV1 Repl. Downstream					
Sample Number:	PW-25-172762	Sampling Time:	N/A	Sample Condition:	Chilled
				Remark:	
Physiochemical Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		19.7	2025-07-25
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-07-22
pH @ 25°C	M6	pH units		4.26	2025-07-25
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		127	2025-07-29
Total Suspended Solids	M8	mg/L		<2.00	2025-07-28
Turbidity	M12	NTU		1.53	2025-07-23

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Company:	Overstrand Munisipaliteit (Umvoto)	Service Request Number:	PW-2025-51626
Address:	Magnolia Street	Date of Certificate:	07-August-2025
	Hermanus	Date Completed:	07-August-2025
	7200	Date of Sampling:	18-July-2025
Contact:	Patrick Robinson	Date of Receiving at Lab:	21-July-2025

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Address:	Magnolia Street	Date of Certificate:	07-August-2025
	Hermanus	Date Completed:	07-August-2025
	7200	Date of Sampling:	18-July-2025
Contact:	Patrick Robinson	Date of Receival at Lab:	21-July-2025

Sample Identification:					
T4/5 Upstream					
Sample Number:	PW-25-172759	Sampling Time:	N/A	Sample Condition:	Chilled
Remark:					
Physiochemical Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		23.1	2025-07-25
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-07-22
pH @ 25°C	M6	pH units		4.30	2025-07-25
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		222	2025-07-29
Total Suspended Solids	M8	mg/L		<2.00	2025-07-28
Turbidity	M12	NTU		4.66	2025-07-23

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Address:	Magnolia Street	Date of Certificate:	07-August-2025
	Hermanus	Date Completed:	07-August-2025
	7200	Date of Sampling:	18-July-2025
Contact:	Patrick Robinson	Date of Receival at Lab:	21-July-2025

Sample Identification:					
T4/5 Downstream					
Sample Number:	PW-25-172760	Sampling Time:	N/A	Sample Condition:	Chilled
Remark:					
Physiochemical Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		27.0	2025-07-25
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-07-22
pH @ 25°C	M6	pH units		4.52	2025-07-25
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		188	2025-07-29
Total Suspended Solids	M8	mg/L		<2.00	2025-07-28
Turbidity	M12	NTU		5.00	2025-07-23

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Service Request Number: PW-2025-51626
Date of Certificate: 07-August-2025
Date Completed: 07-August-2025
Date of Sampling: 18-July-2025
Date of Receival at Lab: 21-July-2025

Contact: Patrick Robinson

Sample Identification:		HAV1 Repl. Upstream			
Sample Number:	PW-25-172761	Sampling Time: N/A	Sample Condition:	Chilled	Remark:
Physiochemical Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		17.0	2025-07-25
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-07-22
pH @ 25°C	M6	pH units		4.56	2025-07-25
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		172	2025-07-29
Total Suspended Solids	M8	mg/L		<2.00	2025-07-28
Turbidity	M12	NTU		1.06	2025-07-23

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Service Request Number: PW-2025-51626
Date of Certificate: 07-August-2025
Date Completed: 07-August-2025
Date of Sampling: 18-July-2025
Date of Receival at Lab: 21-July-2025

Contact: Patrick Robinson

Sample Identification:					
HAV1 Repl. Downstream					
Sample Number:	PW-25-172762	Sampling Time:	N/A	Sample Condition:	Chilled
Remark:					
Physiochemical Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		19.7	2025-07-25
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-07-22
pH @ 25°C	M6	pH units		4.26	2025-07-25
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		127	2025-07-29
Total Suspended Solids	M8	mg/L		<2.00	2025-07-28
Turbidity	M12	NTU		1.53	2025-07-23

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Address:	Magnolia Street	Date of Certificate:	07-August-2025
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	7200	Date of Sampling:	18-July-2025
Contact:	Patrick Robinson	Date of Receiving at Lab:	21-July-2025

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Service Request Number: PW-2025-51888
Date of Certificate: 14-August-2025
Date Completed: 14-August-2025
Date of Sampling: 31-July-2025
Date of Receival at Lab: 06-August-2025

Contact: Patrick Robinson

Sample Identification:					
T4/5 Upstream					
Sample Number:	PW-25-173589	Sampling Time:	N/A	Sample Condition:	Chilled
Remark:					
Physiochemical Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		27.6	2025-08-07
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-08-14
pH @ 25°C	M6	pH units		4.83	2025-08-07
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		311	2025-08-13
Total Suspended Solids	M8	mg/L		<2.00	2025-08-08
Turbidity	M12	NTU		25.8	2025-08-07

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Service Request Number: PW-2025-51888
Date of Certificate: 14-August-2025
Date Completed: 14-August-2025
Date of Sampling: 31-July-2025
Date of Receival at Lab: 06-August-2025

Contact: Patrick Robinson

Sample Identification:					
T4/5 Downstream					
Sample Number:	PW-25-173590	Sampling Time:	N/A	Sample Condition:	Chilled
				Remark:	
Physiochemical Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		30.1	2025-08-07
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-08-14
pH @ 25°C	M6	pH units		5.24	2025-08-07
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		234	2025-08-13
Total Suspended Solids	M8	mg/L		53.0	2025-08-08
Turbidity	M12	NTU		108	2025-08-07

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Address:	Magnolia Street	Date of Certificate:	14-August-2025
	Hermanus	Date Completed:	14-August-2025
	7200	Date of Sampling:	31-July-2025
Contact:	Patrick Robinson	Date of Receival at Lab:	06-August-2025

Sample Identification:					
HAV1 Repl. Upstream					
Sample Number:	PW-25-173591	Sampling Time:	N/A	Sample Condition:	Chilled
				Remark:	
Physiochemical Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		17.0	2025-08-07
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-08-14
pH @ 25°C	M6	pH units		4.64	2025-08-07
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		144	2025-08-13
Total Suspended Solids	M8	mg/L		<2.00	2025-08-08
Turbidity	M12	NTU		1.27	2025-08-07

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Service Request Number: PW-2025-51888
Date of Certificate: 14-August-2025
Date Completed: 14-August-2025
Date of Sampling: 31-July-2025
Date of Receival at Lab: 06-August-2025

Contact: Patrick Robinson

Sample Identification:					
HAV1 Repl. Downstream					
Sample Number:	PW-25-173592	Sampling Time:	N/A	Sample Condition:	Chilled
Remark:					
Physiochemical Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		19.8	2025-08-07
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-08-14
pH @ 25°C	M6	pH units		4.26	2025-08-07
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		332	2025-08-13
Total Suspended Solids	M8	mg/L		<2.00	2025-08-08
Turbidity	M12	NTU		2.44	2025-08-07

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Address:	Magnolia Street	Date of Certificate:	14-August-2025
	Hermanus	Date Completed:	14-August-2025
	7200	Date of Sampling:	31-July-2025
Contact:	Patrick Robinson	Date of Reveal at Lab:	06-August-2025

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Address: Magnolia Street
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Service Request Number: PW-2025-52062
Date of Certificate: 21-August-2025
Date Completed: 21-August-2025
Date of Sampling: 13-August-2025
Date of Receival at Lab: 15-August-2025

Contact: Patrick Robinson

Sample Identification:					
T4/5 upstream					
Sample Number:	PW-25-174232	Sampling Time:	N/A	Sample Condition:	Chilled
Remark:					
Physiochemical Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		20.8	2025-08-20
Fats, Oils & Grease*	M74	mg/L		1.70	2025-08-21
pH @ 25°C	M6	pH units		4.38	2025-08-20
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		115	2025-08-20
Total Suspended Solids	M8	mg/L		<2.00	2025-08-20
Turbidity	M12	NTU		12.7	2025-08-19

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Service Request Number: PW-2025-52062
Date of Certificate: 21-August-2025
Date Completed: 21-August-2025
Date of Sampling: 13-August-2025
Date of Receival at Lab: 15-August-2025

Contact: Patrick Robinson

Sample Identification:					
T4/5 Downstream					
Sample Number:	PW-25-174233	Sampling Time:	N/A	Sample Condition:	Chilled
Remark:					
Physiochemical Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		20.8	2025-08-20
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-08-21
pH @ 25°C	M6	pH units		4.61	2025-08-20
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		246	2025-08-20
Total Suspended Solids	M8	mg/L		<2.00	2025-08-20
Turbidity	M12	NTU		5.62	2025-08-19

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Date of Certificate: 21-August-2025
Date Completed: 21-August-2025
Date of Sampling: 13-August-2025
Date of Receiving at Lab: 15-August-2025

Contact: Patrick Robinson

Sample Identification:					
HAV1 Repl. Upstream					
Sample Number:	PW-25-174234	Sampling Time:	N/A	Sample Condition:	Chilled
Remark:					
Physiochemical Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		15.7	2025-08-20
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-08-21
pH @ 25°C	M6	pH units		4.64	2025-08-20
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		86	2025-08-20
Total Suspended Solids	M8	mg/L		<2.00	2025-08-20
Turbidity	M12	NTU		0.63	2025-08-19

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Address:	Magnolia Street	Date of Certificate:	21-August-2025
	Hermanus	Date Completed:	21-August-2025
	7200	Date of Sampling:	13-August-2025
Contact:	Patrick Robinson	Date of Receival at Lab:	15-August-2025

Sample Identification:		HAV1 Repl. Downstream			
Sample Number:	PW-25-174235	Sampling Time:	N/A	Sample Condition:	Chilled
				Remark:	
Physiochemical Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		17.9	2025-08-20
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-08-21
pH @ 25°C	M6	pH units		4.36	2025-08-20
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		74	2025-08-20
Total Suspended Solids	M8	mg/L		<2.00	2025-08-20
Turbidity	M12	NTU		1.25	2025-08-19

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Address:	Magnolia Street	Date of Certificate:	21-August-2025
	Hermanus	Date Completed:	21-August-2025
	7200	Date of Sampling:	13-August-2025
Contact:	Patrick Robinson	Date of Receival at Lab:	15-August-2025

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Certificate Of Analysis

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Service Request Number: PW-2025-52279
Date of Certificate: 08-September-2025
Date Completed: 08-September-2025
Date of Sampling: 28-August-2025
Date of Receiving at Lab: 29-August-2025

Contact: Patrick Robinson

Sample Identification:					
T4/5 Upstream					
Sample Number:	PW-25-174963	Sampling Time:	N/A	Sample Condition:	Chilled
Remark:					
Physiochemical Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		22.1	2025-09-03
Fats, Oils & Grease*	M74	mg/L		2.40	2025-09-01
pH @ 25°C	M6	pH units		4.68	2025-09-03
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		178	2025-09-03
Total Suspended Solids	M8	mg/L		<2.00	2025-09-08
Turbidity	M12	NTU		17.1	2025-09-01

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Certificate Of Analysis

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Address: Magnolia Street
Hermanus
7200

Service Request Number: PW-2025-52279
Date of Certificate: 08-September-2025
Date Completed: 08-September-2025
Date of Sampling: 28-August-2025
Date of Receiving at Lab: 29-August-2025

Contact: Patrick Robinson

Sample Identification:					
T4/5 Downstream					
Sample Number:	PW-25-174964	Sampling Time:	N/A	Sample Condition:	Chilled
Remark:					
Physiochemical Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		22.3	2025-09-03
Fats, Oils & Grease*	M74	mg/L		1.60	2025-09-01
pH @ 25°C	M6	pH units		4.53	2025-09-03
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		175	2025-09-03
Total Suspended Solids	M8	mg/L		<2.00	2025-09-08
Turbidity	M12	NTU		4.10	2025-09-01

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Date Completed: 08-September-2025
Date of Sampling: 28-August-2025
Date of Receiving at Lab: 29-August-2025

Contact: Patrick Robinson

Sample Identification:					
HAV1 Repl. Upstream					
Sample Number:	PW-25-174965	Sampling Time:	N/A	Sample Condition:	Chilled
Remark:					
Physiochemical Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		15.8	2025-09-03
Fats, Oils & Grease*	M74	mg/L		0.70	2025-09-01
pH @ 25°C	M6	pH units		4.68	2025-09-03
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		139	2025-09-03
Total Suspended Solids	M8	mg/L		<2.00	2025-09-08
Turbidity	M12	NTU		3.12	2025-09-01

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Date of Certificate: 08-September-2025
Date Completed: 08-September-2025
Date of Sampling: 28-August-2025
Date of Receival at Lab: 29-August-2025

Contact: Patrick Robinson

Sample Identification:					
HAV1 Repl. Downstream					
Sample Number:	PW-25-174966	Sampling Time:	N/A	Sample Condition:	Chilled
				Remark:	
Physiochemical Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		19.4	2025-09-03
Fats, Oils & Grease*	M74	mg/L		1.30	2025-09-01
pH @ 25°C	M6	pH units		4.29	2025-09-03
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		135	2025-09-03
Total Suspended Solids	M8	mg/L		<2.00	2025-09-08
Turbidity	M12	NTU		1.89	2025-09-01

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		Date Completed:	08-September-2025
		Date of Sampling:	28-August-2025
Contact:	Patrick Robinson	Date of Receival at Lab:	29-August-2025

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Date Completed: 19-September-2025
Date of Sampling: 08-September-2025
Date of Reveal at Lab: 09-September-2025

Contact: Patrick Robinson

Sample Identification:					
T4/5 Upstream					
Sample Number:	PW-25-175819	Sampling Time:	N/A	Sample Condition:	Chilled
Remark:					
Physiochemical Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		24.5	2025-09-17
Fats, Oils & Grease*	M74	mg/L		0.70	2025-09-19
pH @ 25°C	M6	pH units		4.96	2025-09-17
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		157	2025-09-18
Total Suspended Solids	M8	mg/L		<2.00	2025-09-18
Turbidity	M12	NTU		26.0	2025-09-11

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Date Completed: 19-September-2025
Date of Sampling: 08-September-2025
Date of Receiving at Lab: 09-September-2025

Contact: Patrick Robinson

Sample Identification:					
T4/5 Downstream					
Sample Number:	PW-25-175820	Sampling Time:	N/A	Sample Condition:	Chilled
Remark:					
Physiochemical Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		30.8	2025-09-17
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-09-19
pH @ 25°C	M6	pH units		5.00	2025-09-17
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		156	2025-09-18
Total Suspended Solids	M8	mg/L		3.00	2025-09-18
Turbidity	M12	NTU		14.2	2025-09-11

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Date of Sampling: 08-September-2025
Date of Receiving at Lab: 09-September-2025

Contact: Patrick Robinson

Sample Identification:		HAV1 Repl. Upstream			
Sample Number:	PW-25-175821	Sampling Time:	N/A	Sample Condition:	Chilled
				Remark:	
Physiochemical Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		15.8	2025-09-17
Fats, Oils & Grease*	M74	mg/L		0.50	2025-09-19
pH @ 25°C	M6	pH units		4.69	2025-09-17
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		78	2025-09-18
Total Suspended Solids	M8	mg/L		<2.00	2025-09-18
Turbidity	M12	NTU		1.00	2025-09-11

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Date Completed: 19-September-2025
Date of Sampling: 08-September-2025
Date of Receival at Lab: 09-September-2025

Contact: Patrick Robinson

Sample Identification:					
HAV1 Repl. Downstream					
Sample Number:	PW-25-175822	Sampling Time:	N/A	Sample Condition:	Chilled
				Remark:	
Physiochemical Parameters	Method	Unit	Limit	Result	Analysis Date
Electrical Conductivity @ 25°C	M4	mS/m		19.4	2025-09-17
Fats, Oils & Grease*	M74	mg/L		<0.50	2025-09-19
pH @ 25°C	M6	pH units		4.22	2025-09-17
Total Dissolved Solids @ 105°C (Gravimetric)	M8	mg/L		90	2025-09-18
Total Suspended Solids	M8	mg/L		<2.00	2025-09-18
Turbidity	M12	NTU		2.89	2025-09-11

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	Hermanus	Date Completed:	19-September-2025
	7200	Date of Sampling:	08-September-2025
Contact:	Patrick Robinson	Date of Reveal at Lab:	09-September-2025

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APPENDIX B – FEN Consulting SASS5 Reports



Name: Stephen van Staden
Date: Tuesday, 29 April 2025
Ref: FEN 25-5003

Umvoto Africa (Pty) Ltd
8 Beach Road
Muizenberg
Cape Town
7945
Tel: +27 (0) 21 709 6700
Attention: Gemma Bluff

TECHNICAL MEMORANDUM

RE: THE SASS5 BIOMONITORING RESULTS OF THE RIVER REACHES THAT MAY POTENTIALLY BE IMPACTED AS PART OF THE DEVELOPMENT OF THE HAV1 "REPLACEMENT" AND T4/5 PRODUCTION BOREHOLES, HEMEL EN AARDE WELLFIELD, OVERSTRAND MUNICIPALITY, HERMANUS.





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INTRODUCTION

Freshwater Ecologist Network (FEN) (Pty) Ltd was appointed by Umvoto Africa (Pty) Ltd to undertake the rapid South African Scoring System Version 5 (SASS5) biomonitoring field assessment (Dickens and Graham 2002) on river reaches that may potentially be contaminated as a result of activities related to the construction of the pumphouse and pipelines for both the HAV1 “replacement” and T4/5 boreholes.

The Overstrand Local Municipality has been issued a WUL (No. 18/G40H/A/2377) under Section 21(c) and (i) of the National Water Act (36 of 1998) for production boreholes HAV1 Repl. and T4/5 during pumphouse construction, borehole equipping, and pipeline construction. This WUL requires the following:

A bio-monitoring programme (SASS) must be implemented along the affected length of the watercourse/s and must include a habitat assessment.

Umvoto Africa has requested three (3) sets [1 pre-construction (conducted in January 2025), 1 during construction, 1 post-construction] of rapid SASS5 monitoring of a single upstream and single downstream site for each of the HAV1 Repl. and T4/5 borehole sites.

The location of these sites is provided below in Figure 1.

Biomonitoring has taken place on the 19th of January 2024, 22nd of February 2024, and 28th of March 2024 as part of the borehole drilling phase, and on the 14th of January 2025 on river reaches that are upstream and downstream of the proposed pumphouse and pipelines construction activities. The January 2024 data is representative of baseline conditions prior to borehole development and the February 2024 and March 2024 data is representative of the construction phase for both boreholes. Borehole development involves the discharge of natural groundwater into temporary sumps (stilling basins) which remove sediment out of suspension, after which the groundwater will be discharged via temporary PVC pipelines/existing channels into an area of low sensitivity in a controlled/erosion preventative manner, eventually finding its way into the receiving watercourse.

METHODS

SASS5 is geared at assessing river water quality and river health based on the assemblage of aquatic macro-invertebrates identified amongst stoney, vegetation, and gravel, sand and mud (GSM) biotopes at a given river reach. Each macro-invertebrate is assigned a SASS5 sensitivity score that ranges from 1-15 which is indicative of the degree of tolerance to poor water quality, with a score of 1 indicating highly tolerant, and a score of 15, highly intolerant. The sensitivity scores of the identified taxa (families and orders) are summed per biotope which calculates the SASS score, which when divided by the number of different taxa observed in that biotope determines the Average Score Per Taxon (ASPT) - the average sensitivity of aquatic macro-invertebrates per biotope. It is also possible to calculate these indices across all biotopes to determine the SASS Total Score, number of taxa, and ASPT per site.

The competencies of the SASS rapid field based biomonitoring technique include the following:

- Assessing the ecological state of aquatic ecosystems;
- Assessing the spatial and temporal trends in ecological state;
- Assessing emerging problems;
- Setting objectives for rivers;
- Assessing the impact of developments;
- Predicting changes in the ecosystems due to developments;
- Contributing to the determination of the Ecological Reserve as part of the National Water Act (Act 36 of 1998), as amended.



The biomonitoring assessment included the following aquatic indices:

- Invertebrate Habitat Assessment System (IHAS) - McMillan (1998) which was informed by a survey of general habitat integrity to evaluate the suitability of habitat conditions in allowing for a diverse community of aquatic macro-invertebrates;
- South African Scoring System Version 5 (SASS 5) – which derives the Present Ecological Status (PES) of a river based on the presence of macro-invertebrate families; and
- *In situ* biota specific water quality data was collected to assist in interpreting the biological data, using a calibrated portable multimeter (Hanna Combo pH & EC).

All work was conducted and overseen by a South African River Health Program (SA RHP) SASS5 Accredited Assessor.

Please refer to Figure 1 for the locality map of the sampling sites.

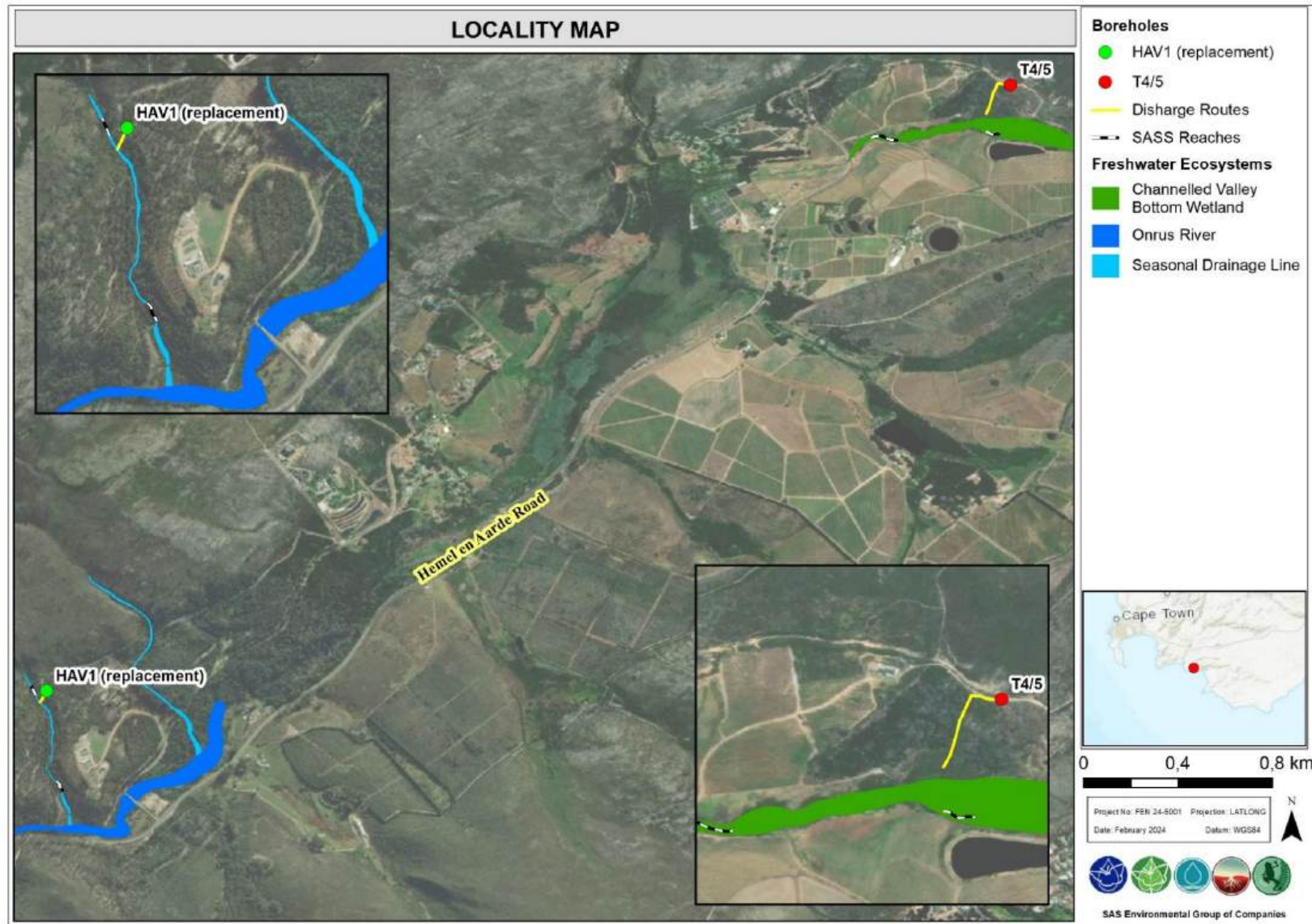


Figure 1: Location of the HAV1 replacement and T4/5 SASS5 sampling reaches in relation to the proposed borehole development discharge routes.



RESULTS

Site Descriptions

HAV1 replacement (upstream): This closed-canopied seasonal mountain stream is a clear light brown colour which is < 1 m wide and ~ 0.15 m deep. A slow shallow run dominated the hydraulic biotope habitat, with occasional shallow pools observed. This stream has had its hydrological budget, marginal and vegetation composition significantly impacted by historic and ongoing *Eucalyptus* tree (Blue Gum) afforestation practices, and subsequent invasion by several *Acacia* (wattle) species. The dominant indigenous marginal vegetation was *Ficinia capillifolium*. Parts of the stream reach were buried underneath alien vegetation debris, and it is envisaged that continued alien invasive vegetation clearing (as observed) will increase the rainfall catchment yield available to this stream, which would increase the hydroperiod and ability of this stream to support a larger vegetation community in future. The water quality of this stream is considered good, despite organic input almost entirely from alien invasive vegetation. During the January 2025 assessment the site was sampled, however, sampling was limited as the site was reduced to a small trickle of water of roughly 5 cm depth.

HAV1 replacement (downstream): The overall vegetation community remained dominated by alien and invasive vegetation, and despite the erosion, the increased stream width (~ 1m), depth (~ 0.3 m) and discharge is able to accommodate a denser and more specious aquatic vegetation community (compared to the upstream site), as evidenced by species such as *Polypogon monspeliensis* (invasive), *Juncus* sp., *Ficinia capillifolia*, and *Carpha glomerata*.

T4/5 (upstream): This river reach within a larger channelled valley bottom wetland had recently undergone large scale erosion, and as a result much of the riverine habitat had been lost. The river further upstream was observed to be in a zero flow condition, and therefore it is suspected that the discharge at this site is likely being supplemented by impoundment seepage or other lateral interflow processes. The stream active channel was ~1 m wide and < 0.1 m deep, was clear and dominated by sand and mud biotopes. The hydrology of the stream was a barely perceptible run. Disturbance of this river bed has allowed for the dominance by pioneering species such as *Pteridium aquilinum* (Bracken fern) and the water quality is considered good, although the water temperature is warmer and the clarity is more turbid than what it would be, compared to if the river was still vegetated.

T4/5 (downstream): This downstream river reach, by comparison, accommodated a much more diverse SASS5 sampling habitat consisting of runs, riffles, pools, and backwaters. Discharge at this site was significantly greater compared to the upstream site, with the river being ~ 1.5 m wide and 0.2 m deep. Although erosion was still very evident at this site, the marginal vegetation out of current was still intact, which provided a good SASS vegetation sampling habitat. Visually the water quality improved significantly at this site and was a clear light brown colour and is considered to be of a very good quality. As with previous assessments, the hydraulic biotopes were regarded as good. Cobbles at the site become increasingly covered with organic soot and is likely due to a general decrease in baseflows over the summer season.

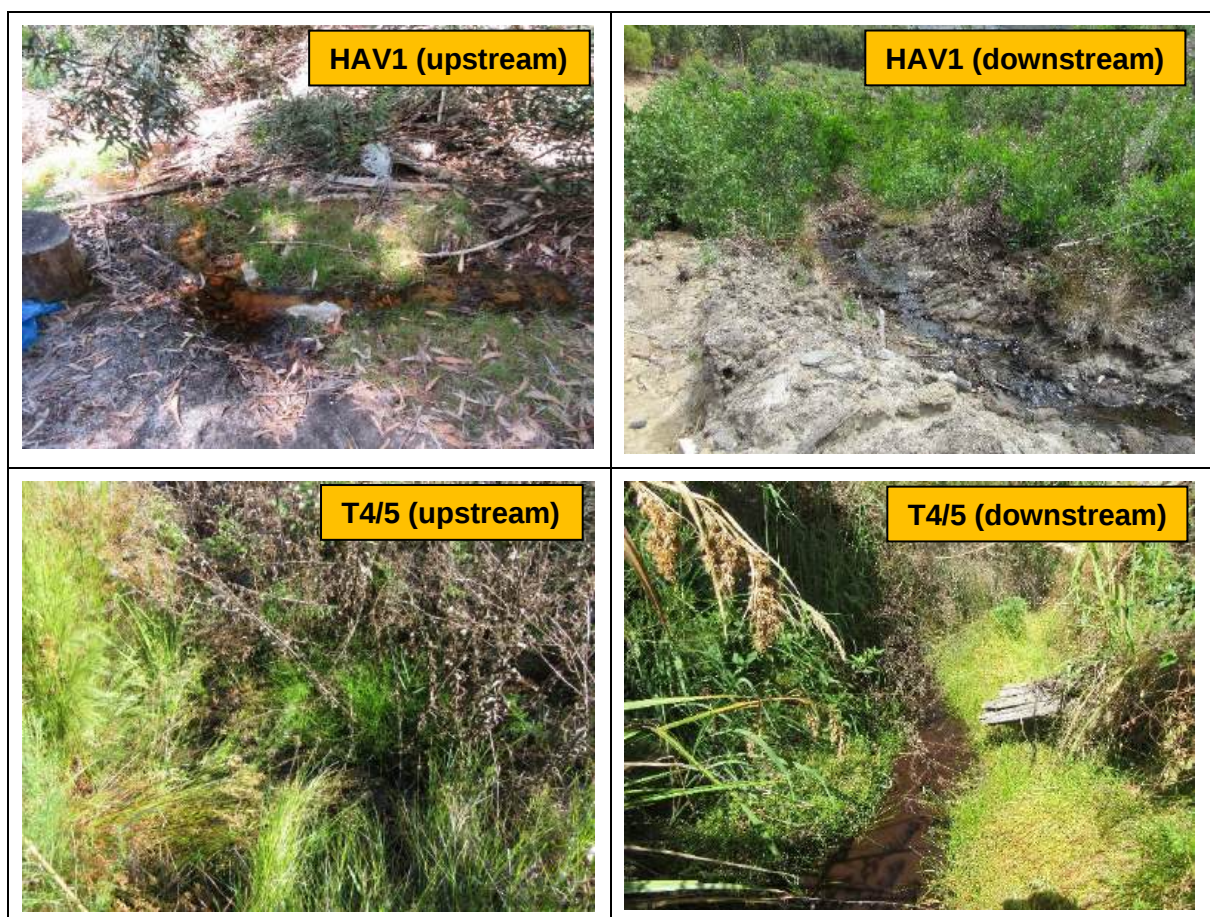


Figure 2: River reaches sampled upstream and downstream of the HAV1 and T4/5 production borehole locations.

During the January 2025 assessment, four biomonitoring sites (Upstream [HAV1] and Downstream [HAV1], along with the upstream [T4/5] and downstream [T4/5]) located on the rivers were assessed. The spatial and temporal evaluation was applied to both sites where applicable.

Results are presented as “dashboard style” reports (Tables 1 to 7). These dashboard reports aim to present concise summaries of the data on as few pages as possible, to allow for integration of results by the reader. Where required, further discussion and interpretation is provided.

**Table 1: Results of the assessment at site HAV1 (located upstream) of the Hemel en Aarde catchment.**

Site HAV1 (US)		In situ physico-chemical water quality				Aquatic macro-invertebrate community integrity			
	Parameter	January 2025	Site specific spatial water quality variations (% var)		Parameter	January 2025	Site specific spatial aquatic invertebrate community variations (% var) from:		
			Parameter	From upstream spatial reference			Parameter	Upstream spatial reference	
	pH	5.33	pH	NA	SASS5 score	73	SASS5	NA (No upstream spatial reference)	
	EC (mS/m)	16.0	EC	(No upstream spatial reference)	Number of taxa	10	ASPT		
	Temp (°C)	19.0	Temp		ASPT score	7.3	IHAS		
	Site specific temporal water quality percentage variations (% var):				Site specific temporal aquatic invertebrate community variations (% var)				
	Parameter	From previous assessment (March 2024)	From baseline (January 2024)	Parameter	From previous assessment (March 2024)	From baseline (January 2024)			
pH	-27.0	+1.9	SASS5	-87.0	-3.9				
EC (mS/m)	+7.0	+7.4	ASPT	-12.0	-13.5				
			IHAS	-3.0	-35.0				
			Taxa	+67.0	+11.0				
Key for spatial and temporal water quality and macro-invertebrate comparisons: Negative value = decrease; Positive value = increase; Normal text = no significant change; Bold text = significant change (compared to guideline); Red text = significant deterioration; Blue text = significant improvement.									
Visual assessment and site description				Key drivers of system change: Water quality: pH was considered slightly acidic and did not comply with the RWQO of South Africa [(6.5 – 8.4) DWA, 2011]. However, this is not uncommon in areas of the Western Cape that tend to have a naturally lower pH level due to geology. EC was considered low and ideal (<30 mS/m), and insignificantly higher compared to the previous monitoring assessment (March 2024) and baseline assessment (January 2024).					
Algal proliferation	None observed on site.			<u>Macro-invertebrate habitat</u> score (IHAS) has decreased insignificantly compared to the previous assessment and significantly compared to the baseline, this is seen as a negative change. The <u>macro-invertebrate diversity</u> (SASS5) scores (measure of diversity) have also significantly decreased when compared to the previous season. <u>ASPT score</u> (measure of sensitivity) has decreased insignificantly over the same period. The IHAS score has decreased significantly when compared to the baseline and this is seen as a negative change. Natural constraints such as low flow (to which increased evaporation contributes due to shallow conditions), with resulting low diversity of flow and habitat types, as well as temporal variation of the surface water levels (perennial nature of the stream) are also likely to affect macro-invertebrate habitat distribution, diversity, and sensitivity scores at this site.					
Depth	Mostly dominated by shallow pools and runs (average depth <1/4 meter).								
Flow condition	Very slow								
Riparian zone characteristics	The riparian zone is dominated by grasses as well as <i>Eucalyptus</i> sp. and wattle sp..								
Water clarity and odour	Clear at time of assessment. No odour present.								
SITE ECOSTATUS CATEGORY									
Variable				Category/ Classification					
SASS5 (Dallas)				B/C (Largely Natural to Moderately modified)					

**Table 2: Results of the assessment at site HAV1 (located downstream) of the Hemel en Aarde catchment.**

Site HAV1 (DS)		In situ physico-chemical water quality				Aquatic macro-invertebrate community integrity			
	Parameter	January 2025	Site specific spatial water quality variations (% var)		Parameter	Jan 2025	Site specific spatial aquatic invertebrate community variations (% var) from:		
			Parameter	From upstream spatial reference			Parameter	Upstream spatial reference	
	pH	4.92	pH	-8.0	SASS5 score	42	SASS5	-42.0	
	EC (mS/m)	32.0	EC	+100.0	Number of taxa	7	ASPT	-18.0	
	Temp (°C)	24.6	Temp	+29.47	ASPT score	6.0	IHAS	-5.41	
	IHAS score				IHAS	37			
Site specific temporal water quality percentage variations (% var):					Site specific temporal aquatic invertebrate community variations (% var)				
Parameter	From previous assessment (March 2024)		From baseline (Jan 2024)		Parameter	From previous season (March 2024)		From baseline (Jan 2024)	
pH	Dry		-27.0 -7.2		SASS5	Dry		-3.9	
EC (mS/m)					ASPT			-13.5	
					IHAS			-35.0	
Key for spatial and temporal water quality and macro-invertebrate comparisons: Negative value = decrease; Positive value = increase; Normal text = no significant change; Bold text = significant change (compared to guideline); Red text = significant deterioration; Blue text = significant improvement.									
Visual assessment and site description					Key drivers of system change: <u>Water quality:</u> pH was considered slightly acidic and did not comply with the RWQO of South Africa [(6.5 – 8.4) DWA, 2011]. However, this is not uncommon in areas of the Western Cape that tend to have a naturally lower pH level due to geology. EC was considered slightly elevated than the normal range (<30 mS/m) and insignificantly lower compared to the baseline assessment (January 2024). The reported pH value was significantly lower and EC concentration significantly higher compared to that of the upstream reference site. <u>Macro-invertebrate habitat score (IHAS)</u> decreased significantly compared to the baseline assessment, however, both the <u>macro-invertebrate diversity (SASS5)</u> and <u>ASPT score</u> scores have decreased insignificantly. When compared to the upstream site, the pH decreased and the EC increased significantly by 8% and 100%, respectively. The SASS5 and ASPT scores decreased significantly by 42% and 18%, respectively. This is seen as a negative change. <u>Natural constraints</u> such as low flow (to which increased evaporation contributes due to shallow conditions) with resulting low diversity of flow and habitat types are also likely to affect macro-invertebrate habitat distribution, diversity, and sensitivity scores at this site. Erosion with resulting sedimentation impact further limiting suitable macro-invertebrate habitat is also a possible negative potential contributor to the macro-invertebrate diversity at this site Impacts and Essential Mitigation: Impacts from seasonal increased flow velocity on the downstream site of the river is clearly visible by the erosion on the banks (Figure 4) which impacts macro-invertebrate diversity and abundances. The slightly elevated EC supports this and is seen as catchment wide impacts on the system.				
Algal proliferation	None observed on site.								
Depth	Mostly dominated by shallow pools (average depth <1/4 meter).								
Flow condition	Slow								
Riparian zone characteristics	The riparian zone is dominated by some grasses but mostly sediment deposits on the banks.								
Water clarity and odour	Sediment deposition on the banks is a contributor to the opaque water clarity and discolouration. No odours present.								
SITE ECOSTATUS CATEGORY									
Variable					Category/ Classification				
SASS5 (Dallas)					D (Largely Modified)				

**Table 3: Results of the assessment at site T4/5 (located upstream) of the Hemel en Aarde catchment.**

Site T4/5 (US)		In situ physico-chemical water quality				Aquatic macro-invertebrate community integrity			
	Parameter	Jan 2025	Site specific spatial water quality variations (% var)		Parameter	Jan 2025	Site specific spatial aquatic invertebrate community variations (% var) from:		
			Parameter	From upstream spatial reference			Parameter	Upstream spatial reference	
	pH	6.54	pH	NA	SASS5 score	49	SASS5	NA (No upstream spatial reference)	
	EC (mS/m)	24.0	EC	(No upstream spatial reference)	Number of taxa	9	ASPT		
	Temp (°C)	18.3	Temp		IHAS score	5.44	IHAS		
Site specific temporal water quality percentage variations (% var):					Site specific temporal aquatic invertebrate community variations (% var)				
Parameter	From previous season (March 2024)		From baseline (Jan 2024)		Parameter	From previous season (March 2024)		From baseline (Jan 2024)	
pH	+19.0		+15.8		SASS5	-76.0		+4.3	
EC (mS/m)	-1.0		+6.2		ASPT	+7.0		+15.7	
					IHAS	-59.0		-9.3	
Key for spatial and temporal water quality and macro-invertebrate comparisons: Negative value = decrease; Positive value = increase; Normal text = no significant change; Bold text = significant change (compared to guideline); Red text = significant deterioration; Blue text = significant improvement.									
Visual assessment and site description					Key drivers of system change: <u>Water quality:</u> pH complied with the RWQO of South Africa [(6.5 – 8.4) DWA, 2011]. pH was significantly higher compared to both the baseline assessment and the previous monitoring season. EC was considered within the normal range (<30 mS/m), and insignificantly higher compared to the baseline assessment (January 2024). <u>Macro-invertebrate</u> habitat score (IHAS) has decreased significantly compared to the previous assessment, which potentially contributed to the decrease of the <u>macro-invertebrate diversity</u> (SASS5) scores over the same period. The <u>ASPT score</u> has increased insignificantly compared to the previous assessment (March 2024) and increased significantly compared to the baseline assessment of January 2024 (both seen as a positive change). <u>Natural constraints</u> such as low flow (to which increased evaporation contributes due to shallow conditions) with resulting low diversity of flow and habitat types are also likely to affect macro-invertebrate habitat distribution, diversity, and sensitivity scores at this site.				
Algal proliferation	None observed on site.								
Depth	Mostly dominated by shallow pools (average depth <1/4 meter).								
Flow condition	Slow								
Riparian zone characteristics	The riparian zone is dominated by reeds and grasses.								
Water clarity and odour	Clear at the time of assessment. No odours present.								
SITE ECOSTATUS CATEGORY									
Variable					Category/ Classification				
SASS5 (Dallas)					D (Largely Modified)				



Table 4: Results of the assessment at site T4/5 (located downstream) of the Hemel en Aarde catchment.

Site T4/5 (DS)		In situ physico-chemical water quality				Aquatic macro-invertebrate community integrity			
	Parameter	Jan 2025	Site specific spatial water quality variations (% var)		Parameter	Jan 2025	Site specific spatial aquatic invertebrate community variations (% var) from:		
			Parameter	From upstream spatial reference			Parameter	Upstream spatial reference	
	pH	6.06	pH	-7.0	SASS5 score	85	SASS5	+73.0	
	EC (mS/m)	45.0	EC	+88.0	Number of taxa	17	ASPT	-8.0	
	Temp (°C)	20.8	Temp	N/A	ASPT score	5	IHAS	+18.0	
	IHAS score	46							
Site specific temporal water quality percentage variations (% var):				Site specific temporal aquatic invertebrate community variations (% var)					
Parameter	From previous season (March 2024)		From baseline (Jan 2024)		Parameter	From previous season (March 2024)		From baseline (Jan 2024)	
pH	+10.0		+10.0		SASS5	-42.0		-25.0	
EC (mS/m)	+53.0		+30.0		ASPT	-15.0		+1.0	
					IHAS	-74.0		-43.0	
Key for spatial and temporal water quality and macro-invertebrate comparisons: Negative value = decrease; Positive value = increase; Normal text = no significant change; Bold text = significant change (compared to guideline); Red text = significant deterioration; Blue text = significant improvement.									
Visual assessment and site description						Key drivers of system change: <u>Water quality:</u> <u>Water quality:</u> pH was considered slightly acidic and did not comply with the RWQO of South Africa [(6.5 – 8.4) DWA, 2011]. However, this is not uncommon in areas of the Western Cape that tend to have a naturally lower pH level due to geology. EC was considered slightly elevated than the normal range (<30 mS/m), and significantly (30%) higher compared to the baseline assessment (January 2024). pH were significantly lower (7%) and EC were significantly higher (88%) compared to the upstream reference, and the previous season assessment (10.0% for pH and 53.0% for EC). <u>Macro-invertebrate habitat score (IHAS)</u> has decreased significantly compared to the previous season (74%) and the baseline (43%), potentially contributing to the decrease observed in the <u>macro-invertebrate diversity (SASS5)</u> scores over the same periods (42% and 25%, respectively). <u>ASPT score</u> has also decreased significantly compared to the previous season (15%). The IHAS and SASS scores have increased significantly when compared to upstream by 73% and 28% respectively, and this is seen as a positive change.			
Algal proliferation	None observed.								
Depth	Mostly dominated by shallow pools and runs (average depth <1/4 meter).								
Flow condition	Still to slow flowing								
Riparian zone characteristics	The riparian zone is dominated by reeds and grasses.								
Water clarity and odour	Clear at time of assessment. No odour present.								
SITE ECOSTATUS CATEGORY									
Variable					Category/ Classification				
SASS5 (Dallas)					D (Largely modified)				

**Table 5: Aquatic macro-invertebrate community comparisons at the HAV1 and T4/5 biomonitoring sites since January 2024.**

			Jan-24	Feb-24	Mar-24	Jan-25	Jan-24	Feb-24	Mar-24	25-Jan	Jan-24	Feb-24	Mar-24	Jan-25	Jan-24	Feb-24	Mar-24	25-Jan
ORDER	FAMILY	SENSITIVITY SCORE	HAV1 (us)				HAV1 (ds)		T4/5 (us)				T4/5 (ds)					
ANNELIDA	<i>Oligochaeta</i>	1												✓				
CRUSTACEA	<i>Amphipoda</i>	13	✓	✓	✓	✓			✓				✓			✓		
	<i>Potamonautidae*</i>	3	✓	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓	✓	✓
PLECOPTERA	<i>Notonemouridae</i>	14	✓				✓									✓		
EPHEMEROPTERA	<i>Baetidae 1 sp.</i>	4				✓				✓	✓			✓				
	<i>Baetidae 2 sp.</i>	6								✓	✓			✓		✓		
	<i>Leptophlebiidae</i>	9													✓			
	<i>Caenidae</i>	6							✓	✓				✓	✓			✓
ODONATA	<i>Chlorolestidae</i>	8	✓	✓														
	<i>Coenagrionidae</i>	4				✓							✓	✓	✓			✓
	<i>Platycnemidae</i>	10		✓														
	<i>Aeshnidae</i>	8								✓	✓	✓		✓	✓	✓		
	<i>Gomphidae</i>	6							✓					✓	✓			✓
HEMIPTERA	<i>Libellulidae</i>	4		✓	✓		✓	✓			✓	✓	✓	✓	✓	✓	✓	✓
	<i>Corixidae*</i>	3					✓		✓	✓	✓	✓		✓	✓	✓	✓	
	<i>Gerridae*</i>	5		✓			✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	
	<i>Hydrometridae*</i>	6												✓				
	<i>Nepidae*</i>	3							✓	✓	✓			✓	✓	✓	✓	✓
	<i>Notonectidae</i>	3									✓					✓		
	<i>Pleidae*</i>	4							✓	✓	✓			✓	✓	✓		
	<i>Veliidae/Mesoveliidae*</i>	5	✓	✓		✓				✓	✓	✓	✓	✓	✓	✓	✓	✓
TRICHOPTERA	<i>Hydropsychidae 1sp</i>	4															✓	✓
	<i>Ecnomidae</i>	8				✓			✓									
CASED CADIS	<i>Philopotamidae</i>	10	✓															
	<i>Barbarochthonidae</i>	13				✓												✓
COLEOPTERA	<i>Leptoceridae</i>	6	✓	✓								✓		✓	✓	✓	✓	✓
	<i>Dytiscidae*</i>	5		✓	✓		✓	✓		✓		✓	✓	✓	✓	✓	✓	✓
	<i>Elmidae*</i>	8								✓				✓		✓		
	<i>Gyrinidae*</i>	5						✓						✓	✓	✓	✓	✓
	<i>Helodidae</i>	12	✓	✓	✓													
	<i>Hydraenidae*</i>	8				✓						✓		✓				✓
	<i>Hydrophilidae*</i>	5	✓				✓		✓	✓	✓			✓	✓	✓	✓	✓
DIPTERA	<i>Athericidae</i>	10					✓							✓	✓	✓		
	<i>Ceratopogonidae</i>	5							✓									
	<i>Chironomidae</i>	2		✓	✓		✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
	<i>Simuliidae</i>	5				✓				✓	✓	✓	✓		✓	✓	✓	✓
	<i>Cuticidae*</i>	1										✓		✓				✓

DRY

The following inferences can be drawn from the above results in Table 5:

HAV1 replacement:

- **Temporally at the upstream site**, both the SASS Total score (which is a measure of macro-invertebrate diversity) and ASPT score (which describes the average sensitivity of macro-invertebrates) insignificantly deteriorated by 3.9% and 13.5%, respectively, for the current assessment compared to the initial January 2024 assessment (baseline). This decrease in both indices is most likely due to the significantly decreasing habitat suitability (IHAS score, by 35%). The decrease in habitat suitability can possibly be seasonally driven with lower base flows compared to the previous assessments. The presence of more taxa during the January 2025 assessment (increased by 11% when compared to the baseline) is a positive change. *Baetidae*, *Gyrinidae*, *Veliidae*, *Philopotamidae*, and *Leptoceridae* were the new species identified at this site during the January 2025 sampling season.
- **Temporally at the downstream site**, no percentage variance could be compared to the previous assessment (March 2024) as the site was dry. The SASS Total score and ASPT score insignificantly decreased by 3.9% and 13.5%, respectively, for the current assessment compared to the initial January 2024 assessment (baseline). This is seen as a negative change and should be monitored. The habitat suitability (IHAS score) decreased by 35.0%. This is seen as a negative change and is indicative of potential impacts on the system. Compared to the previous assessment the new species found at the site were *Potamonautidae*, *Gomphidae*, *Ecnomidae*, *Hydrophilidae*, *Ceratopogonidae*, and *Chironomidae*.



- **Spatial comparisons** indicate that the SASS score and the ASPT decreased significantly by 42% and 18% whilst the IHAS decreased insignificantly by 5%. This is indicative of catchment wide impacts (increasing EC and decreasing pH from upstream to downstream).

T4/5:

- **Temporally at the upstream site**, the SASS Total score increased insignificantly by 4.3% and the ASPT score significantly by 15.7% between the baseline and the current (January 2025) assessment. The IHAS score insignificantly decreased by 9.3% when compared to the January 2024 assessment. When compared to the previous assessment the SASS score decreased significantly by 76% whilst the ASPT score insignificantly increased by 7%. The latter is likely due to the decrease in habitat suitability (IHAS) by 59% when compared to the previous assessment (March 2024). Compared to the previous assessment the new species found at the site were Amphipoda, Coenagrionidae and Dytiscidae.
- **Temporally at the downstream site**, the SASS Total score significantly decreased by 25% with a slight increase in the ASPT score by 1% when compared to the January 2024 assessment. Habitat suitability (IHAS score) decreased by 43% when compared to the baseline and likely contributed to the observed decrease in SASS score as measure of diversity. When compared to the previous assessment the SASS score, ASPT, and IHAS had decreased significantly by 42%, 15% and 74%, respectively. Compared to the previous assessment the new species identified at the site were Caenidae, Coenagrionidae, Gomphidae, Philopotamidae, Hydraenidae, and Culicidae.
- **Spatially between the upstream and downstream sites**, a downstream significant improvement in both SASS5 (73%) and IHAS (18%) scores was noted. The ASPT decreased insignificantly (8%) in a downstream direction. The significant downstream improvement in macro-invertebrate community diversity is likely due to the significant downstream increase in habitat suitability (18%).

As per Figure 7 below which has plotted the SASS Total score (x-axis) against the ASPT (y-axis) within the context of Present Ecological Status (PES). Thresholds “biological bands” for an upper longitudinal profile river in the Southern Folded Mountains Ecoregion, the following inferences can be drawn.

- The HAV1 upstream site deteriorated from a PES Class A (Pristine) ecological condition to a PES Class B/C (Slight to moderately Modified) ecological condition between January 2024 and January 2025 due to a significant decrease in both the SASS5 and ASPT scores;
- The HAV1 downstream site’s ecological condition was a PES Class D (Largely Modified) ecological condition between January 2024 and January 2025 due to a decrease in both the SASS5 and ASPT scores;
- The T4/5 upstream site improved from a PES Class E/F (Severely to Critically Modified) to a PES Class D (Largely Modified) ecological condition between January 2024 and January 2025 assessment, likely due to the significantly increasing SASS5 score and slightly increasing ASPT score; and
- The T4/5 downstream site deteriorated from a PES Class C (Moderately Modified) to a PES Class D (Largely Modified) ecological condition between January 2024 and January 2025 assessment, likely due to the significantly decreasing SASS5 score and ASPT score.

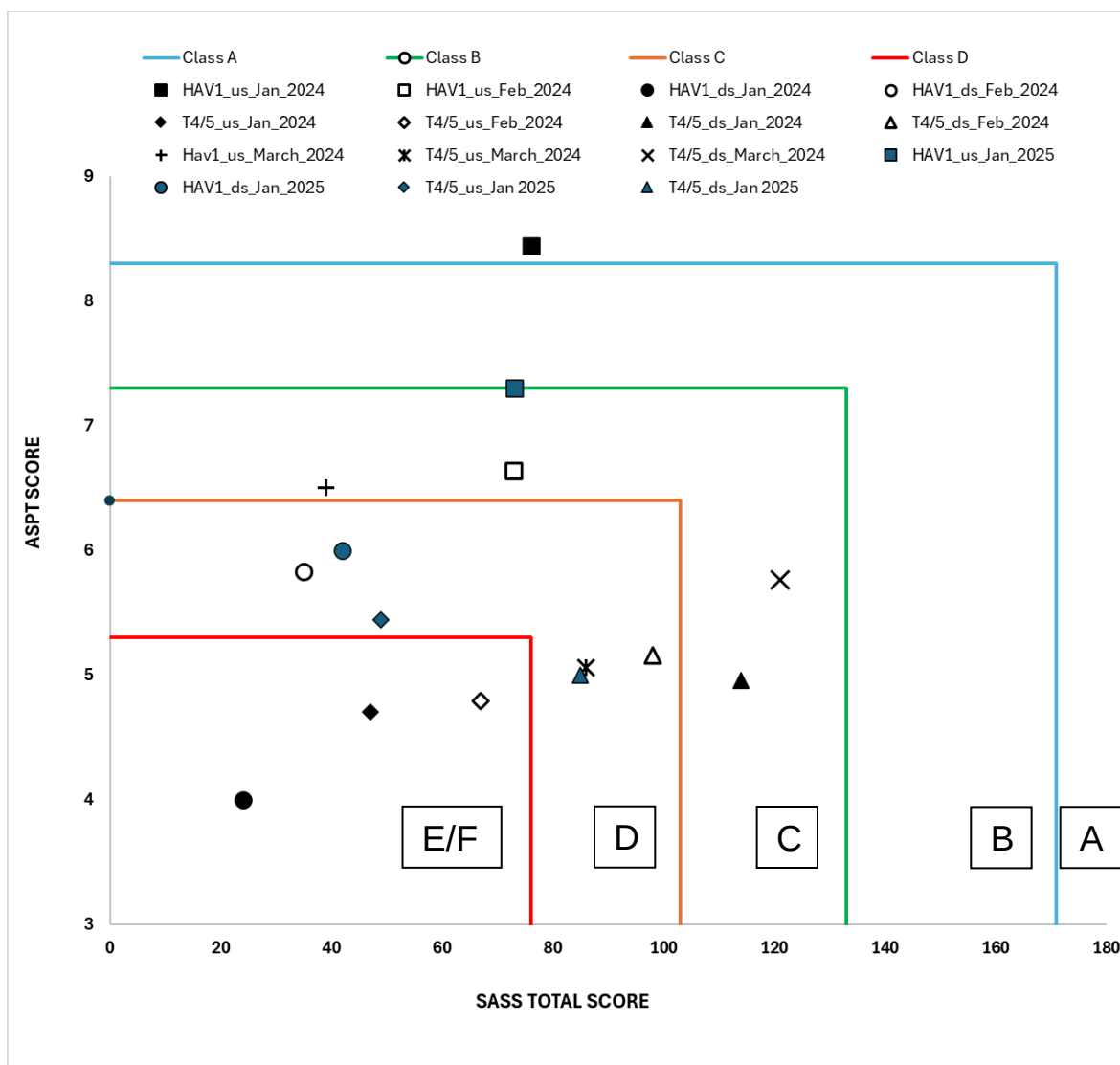
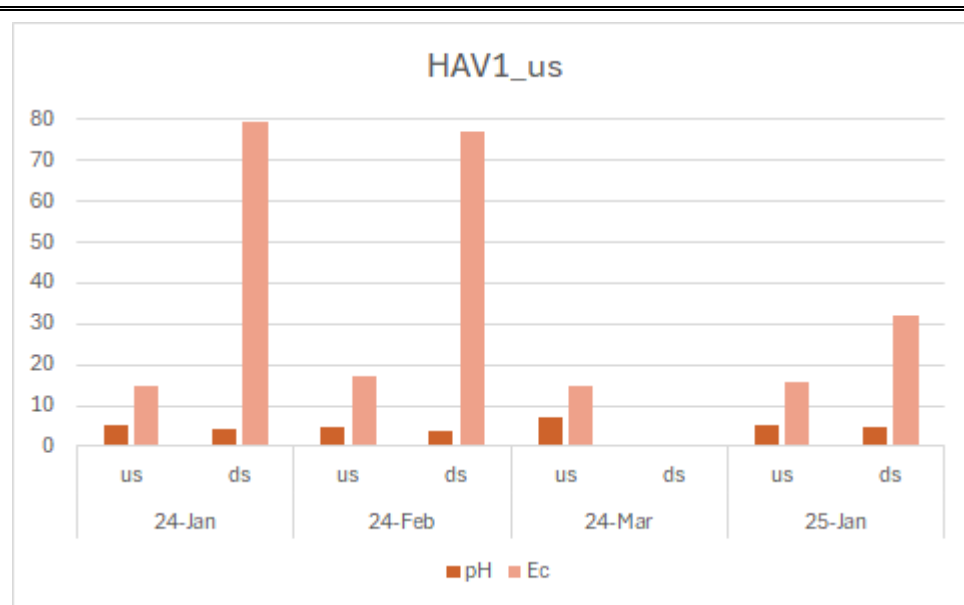


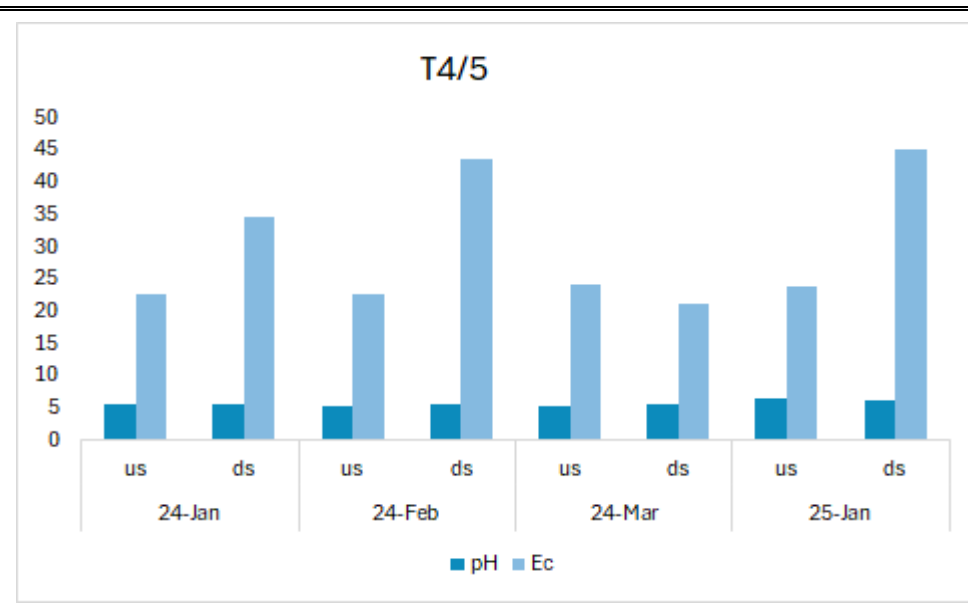
Figure 7: Scatterplots of the SASS total scores and ASPT scores within the context of their PES threshold scores as derived for an upper longitudinal profile river in the Southern Folded Mountains Ecoregion.

In Situ Physico-Chemistry

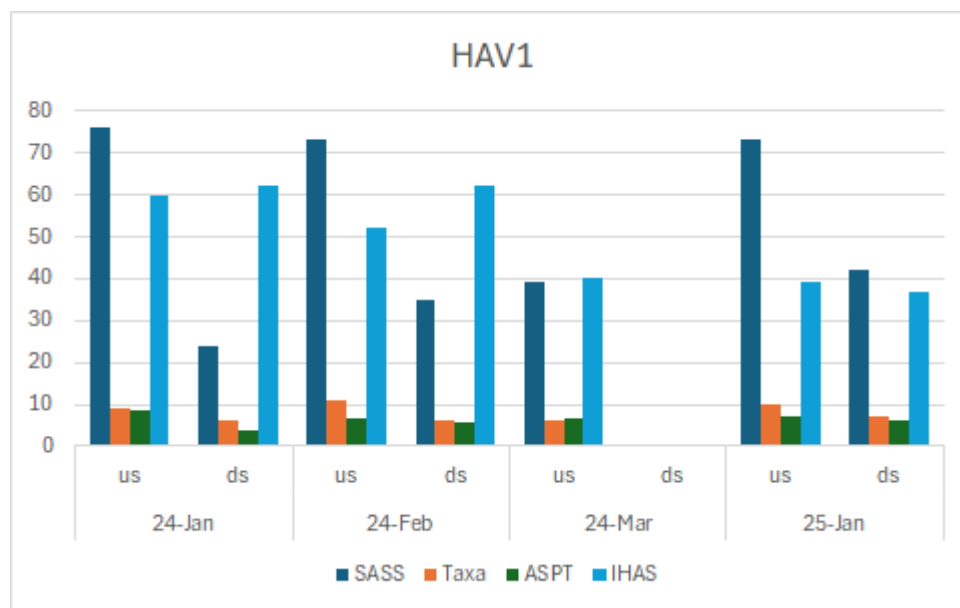
The measured pH and Electrical Conductivity (EC) for the HAV1 and T4/5 biomonitoring sites during the January, February, March 2024, and January 2025 aquatic assessments are tabulated below in Table 4 and graphed below in Figure 5. The percentages in variation of the pH and EC at the HAV1 replacement and T4/5 biomonitoring sites were compared temporally and spatially in Table 6 below as well.

**Table 6: Spatial and temporal variations observed between site HAV1_us and HAV1_ds in January 2025.****Figure 8: Spatial and temporal water quality variation between site HAV1_us****Comment:**

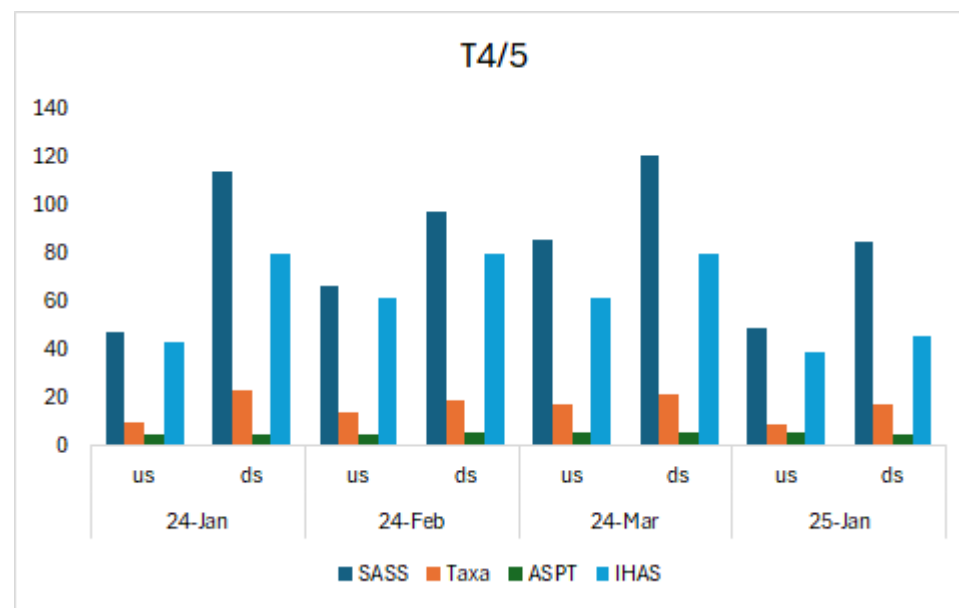
- Spatially, EC increased by 100% in a downstream direction and was considered a significant and negative change. The increase is likely due to cumulative impacts from catchment-wide anthropogenic sources. Seasonal changes such as low rainfall and increased evaporation, potentially contributed to the downstream increase in EC;
- EC had increased by 7% when compared to the baseline (January 2024). Figure 8 shows the trend in EC to increase in a downstream direction in the long term which possibly indicates sources of organic loading, laminar low flow at sites, and catchment-wide activities which impact the river in a downstream direction;
- The pH was below natural levels at all sites and is slightly acidic, a negative impact from pH on sensitive taxa at the time of the January 2025 assessment is anticipated. The pH increased in a downstream direction during the January 2025 assessment (as was shown in previous assessments) which implicates a potential source of acidic contamination between the sites (although variation local geology could be a contributing factor);
- **In conclusion:** The January 2025 assessment results revealed a spatial deterioration in both the measured pH and EC in a downstream direction. As noted before, the majority of environmental deterioration is likely due to catchment-wide impacts compounded by seasonal natural flow constraints and local geology (for pH); and
- Ongoing monitoring at these points will need to continue to monitor existing trends and identify any emerging trends.

**Figure 9: Spatial and temporal water quality variation between site HAV1_ds****Comment:**

- Spatially, EC increased by 88% in a downstream direction and was considered a significant and negative change. The increase is likely due to cumulative impacts from catchment-wide anthropogenic sources. Seasonal changes such as low rainfall and increased evaporation, potentially contributed to the downstream increase in EC;
- EC had increased by 30% when compared to the baseline (January 2024). Figure 9 shows the trend in EC to increase in a downstream direction in the long term which possibly indicates sources of organic loading, laminar low flow at sites, and catchment-wide activities which impact the river in a downstream direction;
- The pH was within natural levels at the upstream site with a 7% decrease in a downstream direction. No negative impact resulting from pH was anticipated at the time of the January 2025 assessment. Previous assessments show that pH remained largely stable;
- **In conclusion:** The January 2025 assessment results revealed a spatial deterioration in the measured EC in a downstream direction. As noted before, the majority of environmental deterioration is likely due to catchment-wide impacts compounded by seasonal natural flow constraints; and
- Ongoing monitoring at these points will need to continue to monitor existing trends and identify any emerging trends.

**Table 7: Spatial macro-invertebrate community integrity variation between site HAV1 and T4/5 in January 2025.****Figure 10: Spatial and temporal macro-invertebrate community integrity variation at HAV1****Comment:**

- Spatially, the macro-invertebrate community SASS and ASPT scores significantly decreased in a downstream direction and deteriorated from a Category B/C (Largely Natural to Moderately Modified) at site HAV1_us to a Category D (Largely Modified) at site HAV1_ds.
- The macro-invertebrate habitat suitability was regarded as 'Poor' at the upstream site (T4/5_us) and 'Poor' the downstream site (T4/5_ds) according to the IHAS classification;
- Spatially, the macro-invertebrate community diversity (SASS5) and ASPT decreased in a downstream direction by 42% and 18%, respectively and in both instances. This was considered significant and negative whereas the IHAS score decreased insignificantly by 5%;
- **In conclusion:** The spatial decrease in macro-invertebrate community integrity (measures of both diversity and sensitivity) is due to seasonal changes, low flow and increased evaporation and catchment wide impacts in a downstream direction. The majority of environmental deterioration is likely due to catchment-wide impacts compounded by seasonal natural flow constraints.

**Figure 11: Spatial and temporal macro-invertebrate community integrity variation at T4/5****Comment:**

- Spatially, the macro-invertebrate community integrity (SASS as measure of diversity) significantly increased in a downstream direction and remained consistent from a Category D (Largely Modified) at site T4/5_us to a Category D (Largely Modified) at site T4/5_ds.
- The macro-invertebrate habitat suitability was regarded as 'Poor' at both the site (T4/5_us) and the downstream site (T4/5_ds) according to the IHAS classification;
- Spatially, the macro-invertebrate community diversity (SASS5) and Habitat suitability (IHAS) increased in a downstream direction by 73% and 18%, respectively and in both instances. This was considered significant and positive whereas the ASPT score decreased insignificantly by 8%;
- **In conclusion:** Ongoing monitoring is recommended to identify long term contributing factors and trends. The majority of environmental deterioration is likely due to catchment-wide impacts compounded by seasonal natural flow constraints and therefore monitoring is essential.



CONCLUSIONS

EC increased downstream by 88-100% at both downstream sites assessed, indicating a significant negative impact, likely due to dissolved ion accumulation and anthropogenic activities in the catchment. Seasonal influences (e.g. low rainfall, evaporation) contributed to the downstream EC increase. Compared to the January 2024 baseline assessment, EC increased by 7-30%, suggesting long-term increasing trends. pH remained within natural levels, but spatial variations suggest possible downstream contamination sources. Overall, the January 2025 assessment showed environmental deterioration, reinforcing the need for ongoing monitoring. Downstream deterioration in macro-invertebrate communities was observed, with a shift from Category B/C (Moderate) to Category D (Largely Modified) at HAV_1. Habitat suitability remained consistent from Poor (upstream) to Poor (downstream) at HAV_1 and T4/5. Macroinvertebrate community diversity (SASS5) and ASPT scores decreased downstream by 42% and 18% at site HAV_1, respectively, indicating negative environmental impact. In contrast, at site T4/5, macro-invertebrate diversity and habitat suitability increased by 73% and 18%, though ASPT slightly declined. Catchment-wide impacts and seasonal flow constraints are likely key contributors to these trends, warranting continued monitoring.

Given the very high erosive damage in the Hemel en Aarde catchment resulting from the recent 2024 winter rains, the streams and rivers in general are regarded as being outside of their normal biotic conditions, both from a habitat quality and water quality perspective. However, despite the above, concerns are raised with respect to significantly decreasing SASS5 and ASPT scores for the HAV1 upstream sites compared to the January 2024 assessment. The deterioration in macro-invertebrate community integrity is most likely due to significantly decreased habitat suitability. No points of concern are raised with respect to the macro-invertebrate community and the associated habitat during the pre-construction phase of the pumphouse and pipelines for both the HAV1 “replacement” and T4/5 boreholes.

RECOMMENDATIONS

- The potential erosion and siltation of streams must be continuously monitored in parallel with the SASS5 biomonitoring assessment, to ensure that the interstitial spaces of the streams, that are used as refugia for eggs and small/juvenile specimens, remain unclogged.
- In the event that the flows dry up to the degree that the SASS5 protocol can no longer be applied, the monitoring programme would need to be adjusted to accommodate the use of diatom and habitat indices that are appropriate under very low to zero flow environmental conditions.
- It is recommended that monitoring continues to identify long term trends by building a database and impacts on the Hemel en Aarde catchment.
- Land-use assessments are recommended to identify catchment-wide activities possibly contributing to the increased EC in a downstream direction.
- Promote the growth of riparian vegetation restoration to stabilize banks, reduce runoff and deposition into the river, and improve habitat conditions for macro-invertebrates.



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APPENDIX A – SASS5 Sheets

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET																		
DATE: 14/01/25	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE: T4_5_us	PORIFERA	5					HEMIPTERA:						DIPTERA:					
S: °	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E: °	TURBELLARIA	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: T4/5 upstream	ANNELIDA:						Gerridae*	5					Ceratopogonidae	5				
RIVER:	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2		1	1	
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	CRUSTACEA:						Nepidae*	3					Dixidae*	10				
TEMP: 18.3 ° C	Amphipoda	13			A	A	Notonectidae*	3					Empididae	6				
Ph: 6.54	Potamonautidae*	3			1	1	Pleidae*	4					Ephydriidae	3				
DO: mg/l	Atyidae	8					Veliidae/M...veliidae*	5			A	A	Muscidae	1				
Cond: 24.0 mS/m	Palaemonidae	10					MEGALOPTERA:						Psychodidae	1				
BIOTOPES SAMPLED:	HYDRACARINA	8					Cordalidae	8					Simuliidae	5			A	A
SIC: TIME: minutes	PLECOPTERA:						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1 sp	4					Hydropsychidae 1 sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosoptomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					SASS SCORE:		0	0	49	49
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		0	0	9	9
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		0.00	0.00	5.44	5.44
	Chlorolestidae	8					Pisuliidae	10					IHAS:		39%			
	Coenagrionidae	4			A	A	Sericostomatidae SWC	13					OTHER BIOTA:					
	Lestidae	8					COLEOPTERA:											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5			1	1	COMMENTS:					
	Protoneuridae	8					Elmidae/Dryopidae*	8			A	A	* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5					SWC = South Western Cape					
	Aeshnidae	8					Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8					S = Stone & rock					
	Libellulidae	4			1	1	Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					



RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 14/01/25	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE: T4_5_ds	PORIFERA	5					HEMIPTERA:						DIPTERA:					
S: °	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E: °	TURBELLARIA	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: T4/5 downstream	ANNELIDA:						Gerridae*	5					Ceratopogonidae	5				
RIVER:	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2		A	1	A
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1			A	A
WEATHER CONDITION:	CRUSTACEA:						Nepidae*	3		1		1	Dixidae*	10				
TEMP: 20.8 ° C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 6.06	Potamonautidae*	3		1	1	A	Pleidae*	4					Ephydriidae	3				
DO: mg/l	Athyidae	8					Veliidae/M...veliidae*	5		A	1	A	Muscidae	1				
Cond: 45.0 mS/m	Palaemonidae	10					MEGALOPTERA:						Psychodidae	1				
BIOTOPES SAMPLED:	HYDRACARINA	8					Cordalidae	8					Simuliidae	5		A	B	B
SIC: TIME: minutes	PLECOPTERA:						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1 sp	4					Hydropsychidae 1 sp	4			A	A	Ancyliidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6			1	1	Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocn.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13			B	B	Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					SASS SCORE:		0	42	68	85
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6			A	A	NO OF TAXA:		0	10	13	17
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		0.00	4.20	5.23	5.00
	Chlorolestidae	8					Pisuliidae	10					IHAS:		46%			
	Coenagrionidae	4		A		A	Sericostomatidae SWC	13					OTHER BIOTA:					
	Lestidae	8					COLEOPTERA:						COMMENTS:					
SIGNS OF POLLUTION:	Platynemidae	10					Dytiscidae*	5		A		A	* = airbreathers					
	Protonemidae	8					Elmidae/Dryopidae*	8					SWC = South Western Cape					
	Zygoptera juvs.	6					Gyrinidae*	5			A	A	T = Tropical					
	Aeshnidae	8					Halipidae*	5					ST = Sub-tropical					
	Corduliidae	8					Helodidae	12					S = Stone & rock					
OTHER OBSERVATIONS:	Gomphidae	6		1	B	B	Hydraenidae*	8			1	1	VG = all vegetation					
	Libellulidae	4		1	1	A	Hydrophilidae*	5		1		1	GSM = gravel, sand & mud					
	LEPIDOPTERA:						Limnichidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					
	Pyralidae	12					Psephenidae	10										



RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 14/01/25	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE: HAV1_us	PORIFERA	5					HEMIPTERA:						DIPTERA:					
S: °	COELENTERATA	1					Belostomatidae*	3					Athericidae	10			1	1
E: °	TURBELLARIA	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: HAV1/US	ANNELIDA:						Gerridae*	5					Ceratopogonidae	5				
RIVER:	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2				
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	CRUSTACEA:						Nepidae*	3					Dixidae*	10				
TEMP: 19.0 ° C	Amphipoda	13			A	A	Notonectidae*	3					Empididae	6				
Ph: 5.33	Potamonautidae*	3			1	1	Pleidae*	4					Ephydriidae	3				
DO: mg/l	Atyidae	8					Veliidae/M...veliidae*	5			A	A	Muscidae	1				
Cond: 16.0 mS/m	Palaemonidae	10					MEGALOPTERA:						Psychodidae	1				
BIOTOPES SAMPLED:	HYDRACARINA	8					Cordalidae	8					Simuliidae	5			A	A
SIC: TIME: minutes	PLECOPTERA:						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8			A	A	GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1 sp	4			1	1	Hydropsychidae 1 sp	4					Ancyidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/MSUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13			A	A	Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					SASS SCORE:		0	0	73	73
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		0	0	10	10
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		0.00	0.00	7.30	7.30
	Chlorolestidae	8					Pisuliidae	10					IHAS:		39%			
	Coenagrionidae	4			1	1	Sericostomatidae SWC	13					OTHER BIOTA:					
	Lestidae	8					COLEOPTERA:						COMMENTS:					
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					* = airbreathers					
	Protoneuridae	8					Elmidae/Dryopidae*	8					SWC = South Western Cape					
	Zygoptera juvs.	6					Gyrinidae*	5					T = Tropical					
	Aeshnidae	8					Halipidae*	5					ST = Sub-tropical					
	Corduliidae	8					Helodidae	12					S = Stone & rock					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8			1	1	VG = all vegetation					
	Libellulidae	4					Hydrophilidae*	5					GSM = gravel, sand & mud					
	LEPIDOPTERA:						Limnichidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					
	Pyralidae	12					Psephenidae	10										



RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET

DATE: 14/01/25	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE: HAV1_ds	PORIFERA	5					HEMIPTERA:						DIPTERA:					
S: °	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E: °	TURBELLARIA	3					Corixidae*	3			1	1	Blepharoceridae	15				
SITE CODE: HAV1 Downstream	ANNELIDA:						Gerridae*	5					Ceratopogonidae	5			A	A
RIVER:	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2			A	A
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	CRUSTACEA:						Nepidae*	3					Dixidae*	10				
TEMP: 24.6 ° C	Amphipoda	13			1	1	Notonectidae*	3					Empididae	6				
Ph: 4.92	Potamonautidae*	3					Pleidae*	4					Ephydriidae	3				
DO: mg/l	Atyidae	8					Veliidae/M...veliidae*	5					Muscidae	1				
Cond: 32.0 mS/m	Palaemonidae	10					MEGALOPTERA:						Psychodidae	1				
BIOTOPES SAMPLED:	HYDRACARINA	8					Cordalidae	8					Simuliidae	5				
SIC: TIME: minutes	PLECOPTERA:						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8			A	A	GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1 sp	4					Hydropsychidae 1 sp	4					Ancyidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/MSUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocn.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					SASS SCORE:		0	0	42	42
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		0	0	7	7
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		0.00	0.00	6.00	6.00
	Chlorolestidae	8					Pisuliidae	10					IHAS:		37%			
	Coenagrionidae	4					Sericostomatidae SWC	13					OTHER BIOTA:					
	Lestidae	8					COLEOPTERA:						COMMENTS:					
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					* = airbreathers					
	Protoneuridae	8					Elmidae/Dryopidae*	8					SWC = South Western Cape					
	Zygoptera juvs.	6					Gyrinidae*	5					T = Tropical					
	Aeshnidae	8					Halipidae*	5					ST = Sub-tropical					
	Corduliidae	8					Helodidae	12					S = Stone & rock					
OTHER OBSERVATIONS:	Gomphidae	6			A	A	Hydraenidae*	8					VG = all vegetation					
	Libellulidae	4					Hydrophilidae*	5			1	1	GSM = gravel, sand & mud					
	LEPIDOPTERA:						Limnichidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					
	Pyralidae	12					Psephenidae	10										



APPENDIX B – IHAS Sheets

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name: Seasonal Stream of the Onrus River	Date: 14/01/25					
Site Name: HAV1 repl upstream						
SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min) (* NOTE: up to 25% of stone is usually embedded in the stream bottom)	0	<1	>1-2	2	>2-3	>3
SIC Score (max 20):						0
VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none		1-25	26-50	51-75	>75
Vegetation Score (max 15):						0
OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time) (** NOTE: you must still fill in the SIC section)		under		corr		over
Other Habitat Score (max 20):						12
HABITAT TOTAL (MAX 55):						12
STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>1	1	>½-1	½	<½-¼	<¼
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	50-80	81-95	>95		
STREAM CONDITIONS TOTAL (MAX 45):						27
TOTAL IHAS SCORE (%):						39



INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name: Seasonal Stream of the Onrus River						
Site Name: HAV1 repl downstream	Date: 14/01/25					
SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min) (* NOTE: up to 25% of stone is usually embedded in the stream bottom)	0	<1	>1-2	2	>2-3	>3
SIC Score (max 20):			0			
VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none		1-25	26-50	51-75	>75
Vegetation Score (max 15):			8			
OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m²' = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
Other Habitat Score (max 20):			11			
HABITAT TOTAL (MAX 55):			19			
STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>1	1	>½-1	½	<½-¼	<¼
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	50-80	81-95	>95		
STREAM CONDITIONS TOTAL (MAX 45):			27			
TOTAL IHAS SCORE (%):			46			



INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name: Perennial stream of the Onrus River						
Site Name: T4/5 upstream	Date: 14/01/25					
SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min) (* NOTE: up to 25% of stone is usually embedded in the stream bottom)	0	<1	>1-2	2	>2-3	>3
SIC Score (max 20):			0			
VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none		1-25	26-50	51-75	>75
Vegetation Score (max 15):			0			
OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m²' = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
Other Habitat Score (max 20):			12			
HABITAT TOTAL (MAX 55):			12			
STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>1	1	>½-1	½	<½-¼	<¼
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	50-80	81-95	>95		
STREAM CONDITIONS TOTAL (MAX 45):			27			
TOTAL IHAS SCORE (%):			39			



INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name: Perennial stream of the Onrus River						
Site Name: T4/5 downstream	Date: 14/01/25					
SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min) (* NOTE: up to 25% of stone is usually embedded in the stream bottom)	0	<1	>1-2	2	>2-3	>3
SIC Score (max 20):			0			
VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none		1-25	26-50	51-75	>75
Vegetation Score (max 15):			0			
OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m²' = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
Other Habitat Score (max 20):			12			
HABITAT TOTAL (MAX 55):			12			
STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>1	1	>½-1	½	<½-¼	<¼
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	50-80	81-95	>95		
STREAM CONDITIONS TOTAL (MAX 45):			25			
TOTAL IHAS SCORE (%):			37			



Name: Rudolf Gouws
Date: Wednesday, 20 August 2025
Ref: FEN 25-5003

Umvoto Africa (Pty) Ltd
8 Beach Road
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Attention: Gemma Bluff

TECHNICAL MEMORANDUM

RE: THE SASS5 BIOMONITORING RESULTS OF THE RIVER REACHES THAT MAY POTENTIALLY BE IMPACTED AS PART OF THE DEVELOPMENT OF THE HAV1 "REPLACEMENT" AND T4/5 PRODUCTION BOREHOLES, HEMEL EN AARDE WELLFIELD, OVERSTRAND MUNICIPALITY, HERMANUS.





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INTRODUCTION

Freshwater Ecologist Network (FEN) (Pty) Ltd was appointed by Umvoto Africa (Pty) Ltd to undertake the rapid South African Scoring System Version 5 (SASS5) (Dickens and Graham 2002) biomonitoring field assessment on river reaches that may potentially be contaminated as a result of activities related to the construction of the pumphouse and pipelines for both the HAV1 “replacement” and T4/5 boreholes.

The Overstrand Local Municipality has been issued a WUL (No. 18/G40H/A/2377) under Section 21(c) and (i) of the National Water Act (36 of 1998) for production boreholes HAV1 Repl. and T4/5 during pumphouse construction, borehole equipping, and pipeline construction. This WUL requires the following:

A bio-monitoring programme (SASS) must be implemented along the affected length of the watercourse/s and must include a habitat assessment.

Umvoto Africa has requested three (3) sets [1 pre-construction (conducted in January 2025), 1 during construction, 1 post-construction] of rapid SASS5 monitoring of a single upstream and single downstream site for each of the HAV1 Repl. and T4/5 borehole sites.

The location of these sites is provided below in Figure 1.

Biomonitoring has taken place on the 19th of January 2024, 22nd of February 2024, and 28th of March 2024 as part of the borehole drilling phase, on the 14th of January 2025, and 22nd of May 2025 on river reaches that are upstream and downstream of the proposed pumphouse and pipelines construction activities. The January 2024 data is representative of baseline conditions prior to borehole development and the February 2024 and March 2024 data is representative of the construction phase for both boreholes. Borehole development includes the discharge of natural groundwater into temporary sumps (stilling basins) which remove sediment out of suspension, after which the groundwater will be discharged via temporary PVC pipelines/existing channels into an area of low sensitivity in a controlled/erosion preventative manner, eventually finding its way into the receiving downgradient watercourse.

METHODS

SASS5 was developed for assessing river water quality and river health based on the assemblage of aquatic macro-invertebrates identified amongst stoney, vegetation, and gravel, sand and mud (GSM) biotopes at a given river reach. Each macro-invertebrate is assigned a SASS5 sensitivity score that ranges from 1-15 which is indicative of the degree of tolerance to deteriorating water quality, with a score of 1 indicating highly tolerant, and a score of 15, highly intolerant. The sensitivity scores of the identified taxa (families and orders) are summed per biotope and the sum of all taxa observed across all biotopes calculates the SASS score, when this score per biotope as well as the total SASS score is divided by the number of different taxa observed in that biotope the Average Score Per Taxon (ASPT) can be calculated - the average sensitivity of aquatic macro-invertebrates per biotope. The SASS5 score and ASPT gives an indication of community sensitivity and diversity and any changes in these aspects can indicate an improving or deteriorating environment.

The competencies of the SASS rapid field based biomonitoring technique include the following:

- Assessing the ecological state of aquatic ecosystems;
- Assessing the spatial and temporal trends in ecological state;
- Assessing emerging problems;
- Setting objectives for rivers;
- Assessing the impact of developments;



- Predicting changes in the ecosystems due to developments;
- Contributing to the determination of the Ecological Reserve as part of the National Water Act (Act 36 of 1998), as amended.

The biomonitoring assessment included the following aquatic indices:

- Invertebrate Habitat Assessment System (IHAS) - McMillan (1998) which was informed by a survey of general habitat integrity to evaluate the suitability of habitat conditions in allowing for a diverse community of aquatic macro-invertebrates;
- South African Scoring System Version 5 (SASS 5) – which derives the Present Ecological Status (PES) of a river based on the presence of macro-invertebrate families; and
- *In situ* biota specific water quality data was collected to assist in interpreting the biological data, using a calibrated portable multimeter (ExStik II).

All work was conducted and overseen by a South African River Health Program (SA RHP) SASS5 Accredited Assessor.

Please refer to Figure 1 for the locality map of the sampling sites.

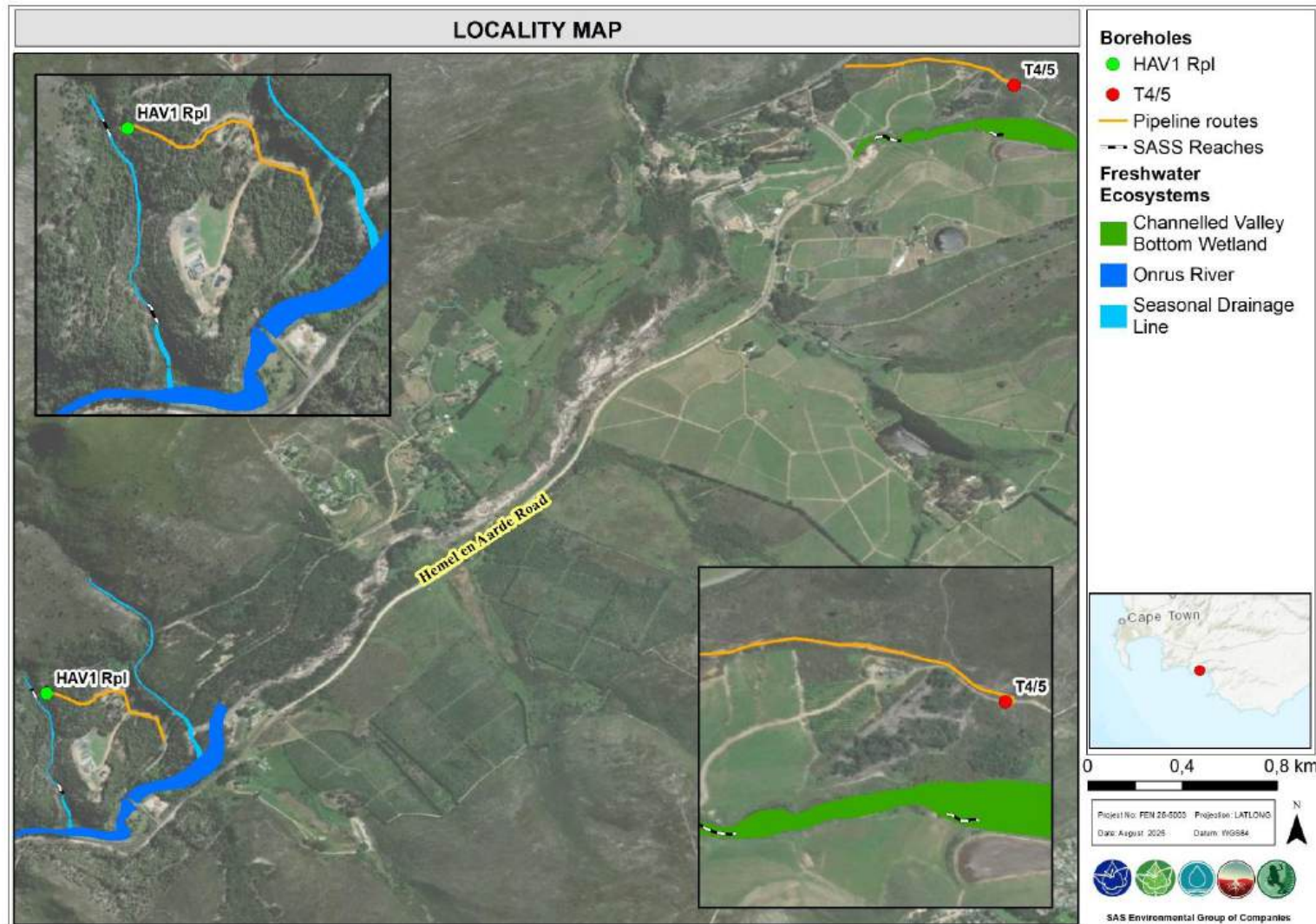


Figure 1: Location of the HAV1 replacement and T4/5 SASS5 sampling reaches in relation to the proposed borehole development discharge routes.



RESULTS

Site Descriptions

HAV1 replacement (upstream): This closed-canopied seasonal mountain stream is a clear light brown (tannin enriched) colour which is < 1 m wide and ~ 0.15 m deep. A slow shallow run dominated the hydraulic biotope habitat, with occasional shallow pools observed. This stream has had its hydrological budget, marginal and vegetation composition significantly impacted by historic and ongoing *Eucalyptus* tree (Blue Gum) afforestation practices, and subsequent invasion by several *Acacia* (wattle) species. The dominant indigenous marginal vegetation was *Ficinia capillifolium*. Parts of the stream reach were buried underneath alien vegetation debris, and it is envisaged that continued alien invasive vegetation clearing (as observed) will increase the rainfall catchment yield available to this stream, which would increase the hydroperiod and ability of this stream to support a larger vegetation community in future. The water quality of this stream is considered good, despite organic input almost entirely from alien invasive vegetation. During the May 2025 assessment the site was sampled, however, sampling was limited as the site was reduced to very shallow trickle of water of roughly 5 cm depth.

HAV1 replacement (downstream): The overall vegetation community remained dominated by alien and invasive vegetation.

T4/5 (upstream): This river reach within a larger channelled valley bottom wetland had recently undergone large scale erosion, and as a result much of the riverine habitat had been lost. The river further upstream was observed to be in a zero flow condition, and therefore it is suspected that the discharge at this site is likely being supplemented by impoundment seepage or other lateral interflow processes. The stream active channel was ~1 m wide and < 0.1 m deep, was clear and dominated by sand and mud biotopes. The hydrological profile of the stream reach was a barely perceptible run. Disturbance of this river bed has allowed for the dominance by pioneering species such as *Pteridium aquilinum* (Bracken fern) and the water quality is considered good.

T4/5 (downstream): This downstream river reach, by comparison, accommodated a much more diverse SASS5 sampling habitat consisting of runs, riffles, pools, and backwaters. Discharge at this site was significantly greater compared to the upstream site, with the river being ~ 1.5 m wide and 0.2 m deep. Although erosion was still very evident at this site, the marginal vegetation out of current was still intact, which provided a good SASS vegetation sampling habitat. Visually the water quality improved significantly at this site and was a clear light brown colour and is considered to be of a very good quality. As with previous assessments, the hydraulic biotopes were regarded as good. Cobbles at the site become increasingly covered with organic material and is likely due to a general decrease in baseflows over the summer season.

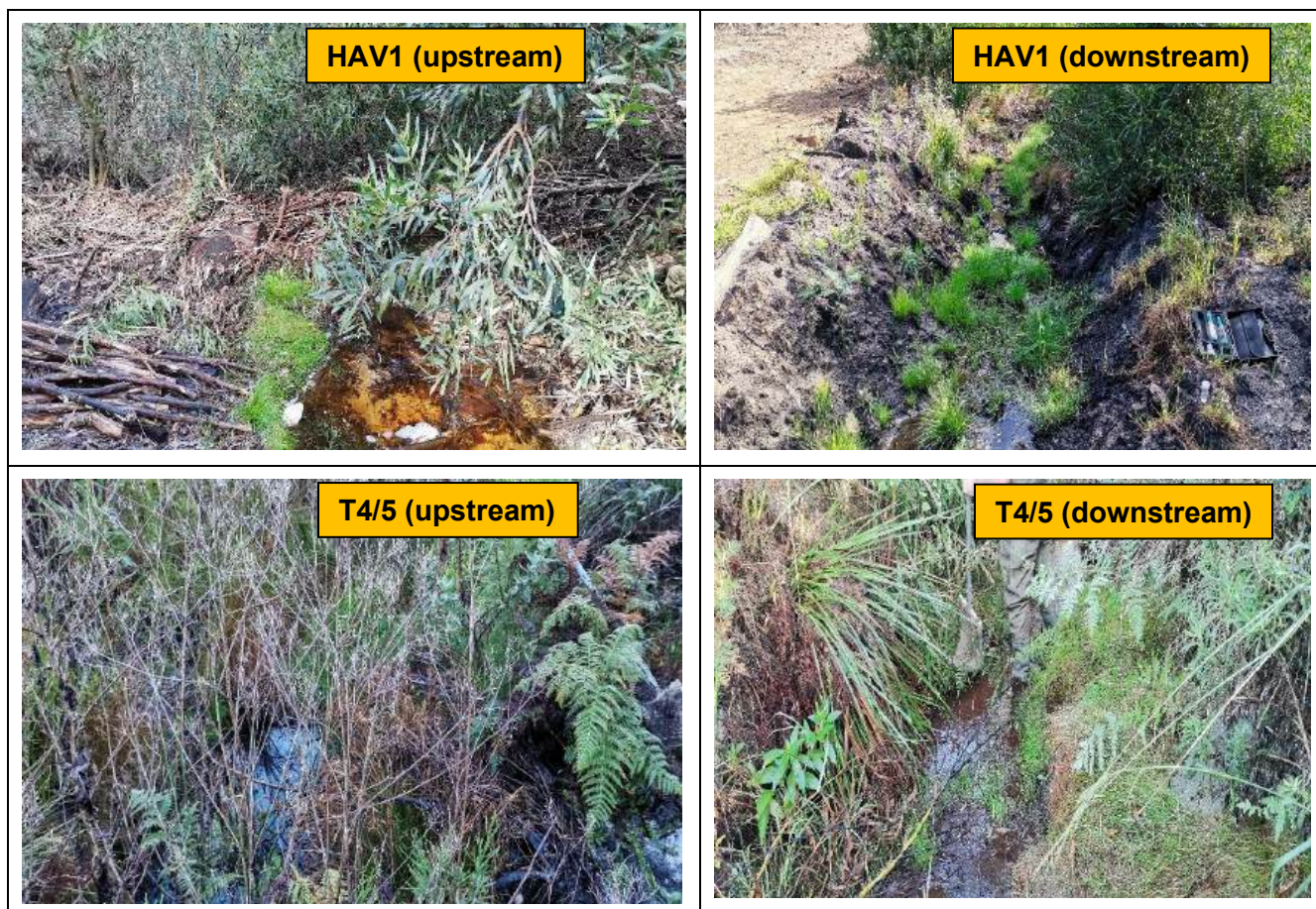


Figure 2: River reaches sampled upstream and downstream of the HAV1 Replacement and T4/5 production borehole locations.

During the May 2025 assessment, four biomonitoring sites (Upstream [HAV1 Replacement] and Downstream [HAV1 Replacement], along with the upstream [T4/5] and downstream [T4/5]) located on the rivers were assessed. The spatial and temporal evaluation was applied to both sites where applicable. However, site HAV1 Replacement downstream was not sampled for the May 2025 assessment due to insufficient flow.

Results are presented as “dashboard style” reports (Tables 1 to 7). These dashboard reports aim to present concise summaries of the data on as few pages as possible, to allow for integration of results by the reader. Where required, further discussion and interpretation is provided.

**Table 1: Results of the assessment at site HAV1 Replacement (located upstream) of the Hemel en Aarde catchment.**

Site HAV1 (US)		In situ physico-chemical water quality				Aquatic macro-invertebrate community integrity			
	Parameter	May 2025	Site specific spatial water quality variations (% var)		Parameter	May 2025	Site specific spatial aquatic invertebrate community variations (% var) from:		
			Parameter	From upstream spatial reference			Parameter	Upstream spatial reference	
	pH	4.94	pH	NA	SASS5 score	66	SASS5	NA (No upstream spatial reference)	
	EC (mS/m)	16.5	EC	(No upstream spatial reference)	Number of taxa	8	ASPT		
	Temp (°C)	21.4	Temp		IHAS score	8.25	IHAS		
	Site specific temporal water quality percentage variations (% var):				Site specific temporal aquatic invertebrate community variations (% var)				
Parameter	From previous season (March 2024)	From baseline (January 2024)	Parameter	From previous season (March 2024)	From baseline (January 2024)				
pH	-32.3	-5.5	SASS5	+69.2	-13.2				
EC (mS/m)	+10.6	+10.7	ASPT	+26.9	-2.3				
			IHAS	+25.0	-16.7				
			Taxa	+33.3	-11.1				
Key for spatial and temporal water quality and macro-invertebrate comparisons: Negative value = decrease; Positive value = increase; Normal text = no significant change; Bold text = significant change (compared to guideline); Red text = significant deterioration; Blue text = significant improvement.									
Visual assessment and site description				Key drivers of system change: <u>Water quality:</u> pH was considered slightly acidic and did not comply with the RWQO of South Africa [(6.5 – 8.4) DWA, 2011]. However, this is not uncommon in areas of the Western Cape that tend to have a naturally lower pH level due to geology. EC was considered low and ideal (<30 mS/m), and insignificantly higher compared to the previous monitoring season (January 2025) and baseline assessment (January 2024). <u>Macro-invertebrate habitat score (IHAS)</u> has increased significantly compared to the previous season and decreased significantly compared to the baseline, this is seen as a positive change when compared to previous season. The macro-invertebrate diversity (SASS5) scores (measure of diversity) have significantly increased when compared to the previous season. <u>ASPT score</u> (measure of sensitivity) has increased significantly over the same period. <u>Natural constraints</u> such as limited depth and flow (to which increased evaporation contributes due to shallow conditions), with resulting low diversity of flow and habitat/substrate types, as well as temporal variation of the surface water levels (perennial nature of the stream) are also likely to affect macro-invertebrate habitat distribution, diversity, and sensitivity scores at this site.					
Algal proliferation	None observed on site.								
Depth	Mostly dominated by shallow pools and runs (average depth <1/4 meter).								
Flow condition	Very slow								
Riparian zone characteristics	The riparian zone is dominated by grasses as well as <i>Eucalyptus</i> sp. and wattle sp.								
Water clarity and odour	Clear at time of assessment. No odour present.								
SITE ECOSTATUS CATEGORY									
Variable				Category/ Classification					
SASS5 (Dallas)				B (Largely Natural)					

**Table 2: Results of the assessment at site HAV1 Replacement (located downstream) of the Hemel en Aarde catchment.**

Site HAV1 (DS)		In situ physico-chemical water quality				Aquatic macro-invertebrate community integrity			
	Parameter	May 2025	Site specific spatial water quality variations (% var)		Parameter	May 2025	Site specific spatial aquatic invertebrate community variations (% var) from:		
			Parameter	From upstream spatial reference			Parameter	Upstream spatial reference	
	pH	4.58	pH	-7.3	SASS5 score	-	SASS5	-	
	EC (mS/m)	17.9	EC	+8.5	Number of taxa	-	ASPT	-	
	Temp (°C)	21.7	Temp	N/A	ASPT score	-	IHAS	-	
	IHAS score								
Site specific temporal water quality percentage variations (% var):				Site specific temporal aquatic invertebrate community variations (% var)					
Parameter	From previous season (March 2024)		From baseline (Jan 2024)		Parameter	From previous season (March 2024)		From baseline (Jan 2024)	
pH	Dry		+11.4		SASS5	Dry		-	
EC (mS/m)			-77.5		ASPT			-	
					IHAS			-	
Key for spatial and temporal water quality and macro-invertebrate comparisons: Negative value = decrease; Positive value = increase; Normal text = no significant change; Bold text = significant change (compared to guideline); Red text = significant deterioration; Blue text = significant improvement.									
Visual assessment and site description					Key drivers of system change: <u>Water quality:</u> pH was considered slightly acidic and did not comply with the RWQO of South Africa [(6.5 – 8.4) DWA, 2011]. However, this is not uncommon in areas of the Western Cape that tend to have a naturally lower pH level due to geology. EC was considered low and ideal (<30 mS/m) and significantly higher compared to the baseline assessment (January 2024). The reported pH value was significantly lower and EC concentration insignificantly higher compared to that of the upstream reference site. <u>Macro-invertebrate habitat score (IHAS), macro-invertebrate diversity (SASS5) and ASPT score</u> could not be calculated due to the site being dry. <u>Natural constraints</u> such as low flow (to which increased evaporation contributes due to shallow conditions) with resulting low diversity of flow and habitat types are also likely to affect macro-invertebrate habitat distribution, diversity, and sensitivity scores at this site. Erosion with resulting sedimentation impact further limiting suitable macro-invertebrate habitat is also a possible negative potential contributor to the macro-invertebrate diversity at this site. Impacts and Essential Mitigation: Impacts from seasonal increased flow velocity on the downstream site of the river is clearly visible by the erosion on the banks (Figure 4) which impacts macro-invertebrate diversity and abundances. The slightly elevated EC supports this and is seen as catchment wide impacts on the system.				
Algal proliferation	None observed on site.								
Depth	Mostly dominated by shallow pools (average depth <1/4 meter).								
Flow condition	Slow								
Riparian zone characteristics	The riparian zone is dominated by some grasses but mostly sediment deposits on the banks.								
Water clarity and odour	Sediment deposition on the banks is a contributor to the opaque water clarity and discolouration. No odours present.								
SITE ECOSTATUS CATEGORY									
Variable					Category/ Classification				
SASS5 (Dallas)					-				

**Table 3: Results of the assessment at site T4/5 (located upstream) of the Hemel en Aarde catchment.**

Site T4/5 (US)		In situ physico-chemical water quality				Aquatic macro-invertebrate community integrity			
	Parameter	May 2025	Site specific spatial water quality variations (% var)		Parameter	May 2025	Site specific spatial aquatic invertebrate community variations (% var) from:		
			Parameter	From upstream spatial reference			Parameter	Upstream spatial reference	
	pH	5.51	pH	NA	SASS5 score	25	SASS5	NA (No upstream spatial reference)	
	EC (mS/m)	26.2	EC	(No upstream spatial reference)	Number of taxa	6	ASPT		
	Temp (°C)	21.3	Temp		IHAS score	44	IHAS		
	Site specific temporal water quality percentage variations (% var):				Site specific temporal aquatic invertebrate community variations (% var)				
	Parameter	From previous season (March 2024)		From baseline (Jan 2024)	Parameter	From previous season (March 2024)		From baseline (Jan 2024)	
	pH	+4.2		-2.5	SASS5	-70.9		-46.8	
	EC (mS/m)	+7.8		+15.9	ASPT	-17.6		-11.3	
				IHAS	-29.0		+2.3		
Key for spatial and temporal water quality and macro-invertebrate comparisons: Negative value = decrease; Positive value = increase; Normal text = no significant change; Bold text = significant change (compared to guideline); Red text = significant deterioration; Blue text = significant improvement.									
Visual assessment and site description				Key drivers of system change: <u>Water quality:</u> pH was considered slightly acidic and did not comply with the RWQO of South Africa [(6.5 – 8.4) DWA, 2011]. pH was slightly lower compared to the baseline assessment and slightly higher compared to previous monitoring season. EC was considered within the normal range (<30 mS/m), and significantly higher compared to the baseline assessment (January 2024) and insignificantly higher when compared to previous season. <u>Macro-invertebrate habitat score (IHAS)</u> has decreased significantly compared to the previous season assessment, which potentially contributed to the decrease of the <u>macro-invertebrate diversity (SASS5)</u> scores over the same period. The <u>ASPT score</u> has decreased significantly compared to the previous season assessment (March 2024) and decreased insignificantly compared to the baseline assessment of January 2024 (both seen as a negative change). <u>Natural constraints</u> such as low flow (to which increased evaporation contributes due to shallow conditions) with resulting low diversity of flow and habitat types are also likely to affect macro-invertebrate habitat distribution, diversity, and sensitivity scores at this site.					
Algal proliferation	None observed on site.								
Depth	Mostly dominated by shallow pools (average depth <1/4 meter).								
Flow condition	Slow								
Riparian zone characteristics	The riparian zone is dominated by reeds and grasses.								
Water clarity and odour	Clear at the time of assessment. No odours present.								
SITE ECOSTATUS CATEGORY									
Variable				Category/ Classification					
SASS5 (Dallas)				E/F (Severely Modified)					

**Table 4: Results of the assessment at site T4/5 (located downstream) of the Hemel en Aarde catchment.**

Site T4/5 (DS)		In situ physico-chemical water quality				Aquatic macro-invertebrate community integrity			
	Parameter	May 2025	Site specific spatial water quality variations (% var)		Parameter	May 2025	Site specific spatial aquatic invertebrate community variations (% var) from:		
			Parameter	From upstream spatial reference			Parameter	Upstream spatial reference	
	pH	5.54	pH	+0.5	SASS5 score	61	SASS5	+144.0	
	EC (mS/m)	30.8	EC	+17.6	Number of taxa	11	ASPT	+33.1	
	Temp (°C)	21.2	Temp	N/A	ASPT score	5.55	IHAS	+40.9	
	IHAS score	62							
Site specific temporal water quality percentage variations (% var):				Site specific temporal aquatic invertebrate community variations (% var)					
Parameter	From previous season (March 2024)		From baseline (Jan 2024)		Parameter	From previous season (March 2024)		From baseline (Jan 2024)	
pH	+1.3		+0.2		SASS5	-49.6		-46.0	
EC (mS/m)	+44.6		-10.7		ASPT	-3.6		+12.0	
					IHAS	-22.5		-23.0	
Key for spatial and temporal water quality and macro-invertebrate comparisons: Negative value = decrease; Positive value = increase; Normal text = no significant change; Bold text = significant change (compared to guideline); Red text = significant deterioration; Blue text = significant improvement.									
Visual assessment and site description					Key drivers of system change: <u>Water quality:</u> <u>Water quality:</u> pH was considered slightly acidic and did not comply with the RWQO of South Africa [(6.5 – 8.4) DWA, 2011]. However, this is not uncommon in areas of the Western Cape that tend to have a naturally lower pH level due to geology. EC was considered slightly elevated than the normal range (<30 mS/m), and slightly lower compared to the baseline assessment (January 2024). pH were insignificantly higher (0.5%) and EC were significantly higher (17.6%) compared to the upstream reference, and the previous season assessment (1.3% for pH and 44.6% for EC). <u>Macro-invertebrate habitat score (IHAS)</u> has decreased significantly compared to the previous season (22.5%) and the baseline (23%), potentially contributing to the decrease observed in the <u>macro-invertebrate diversity (SASS5)</u> scores over the same periods (49.6% and 46%, respectively). <u>ASPT score</u> has decreased insignificantly compared to the previous season (3.6%). The IHAS and SASS scores have increased significantly when compared to upstream by 40.9% and 144.0% respectively, and this is seen as a positive change.				
Algal proliferation	None observed.								
Depth	Mostly dominated by shallow pools and runs (average depth <1/4 meter).								
Flow condition	Still to slow flowing								
Riparian zone characteristics	The riparian zone is dominated by reeds and grasses.								
Water clarity and odour	Clear at time of assessment. No odour present.								
SITE ECOSTATUS CATEGORY									
Variable					Category/ Classification				
SASS5 (Dallas)					D (Largely modified)				

Table 5: Aquatic macro-invertebrate community comparisons at the HAV1 Replacement and T4/5 biomonitoring sites since January 2024.

		Jan-24		Feb-24		Mar-24		Jan-25		May-25		Jan-24		Feb-24		Mar-24		Jan-25		May-25		Jan-24		Feb-24		Mar-24		Jan-25		May-25	
ORDER	FAMILY	SENSITIVITY SCORE	HAV1 (us)						HAV1 (ds)						T4/5 (us)						T4/5 (ds)										
ANNELIDA	Oligochaeta	1																													
CRUSTACEA	Amphipoda	13	✓	✓	✓	✓	✓					✓																			
	Potamonautidae *	3	✓	✓	✓	✓	✓	✓																							
PLECOPTERA	Notonemouridae	14	✓							✓																					
	Baetidae 1 sp.	4					✓																								
EPHEMEROPTERA	Baetidae 2 sp.	6																													
	Leptaphlebiidae	9																													
ODONATA	Caenidae	6																													
	Chlorolestidae	8	✓	✓																											
	Coenagrionidae	4					✓		✓																						
	Platycnemididae	10		✓																											
	Aeshnidae	8																													
	Gomphidae	6											✓																		
HEMIPTERA	Libellulidae	4			✓	✓					✓	✓																			
	Corixidae *	3										✓																			
	Gerridae *	5			✓						✓	✓																			
	Hydrometridae *	6																													
TRICHOPTERA	Nepidae *	3																													
	Notonectidae	3																													
	Pleidae *	4																													
	Velutidae/Mesovelutidae *	5	✓	✓			✓																								
CASED CADIS	Hydropsychidae 1sp	4																													
	Ecnomidae	8					✓						✓																		
	Philopotamidae	10	✓																												
COLEOPTERA	Barbarochthonidae	13					✓		✓																						
	Leptoceridae	6	✓	✓					✓																						
	Dytiscidae *	5		✓	✓				✓	✓	✓																				
DIPTERA	Elmidae *	8																													
	Gyrinidae *	5																													
	Helodidae	12	✓	✓	✓			✓																							
	Hydraenidae *	8					✓																								
DIPTERA	Hydrophilidae *	5	✓						✓				✓																		
	Atherichidae	10							✓																						
	Ceratopogonidae	5											✓																		
	Chironomidae	2		✓	✓				✓	✓					✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
	Simuliidae	5					✓																								
	Culicidae *	1																													

The following inferences can be drawn from the above results in Table 5:

HAV1 replacement:

- **Temporally at the upstream site**, both the SASS Total score (which is a measure of macro-invertebrate diversity) and ASPT score (which describes the average sensitivity of macro-invertebrates) insignificantly deteriorated by 13.2% and 2.3%, respectively, for the current assessment compared to the initial January 2024 assessment (baseline). The presence of less taxa during the May 2025 assessment (decrease by 11.1% when compared to the baseline) is a negative change. This decrease in both indices is most likely due to the significantly decreasing habitat suitability (IHAS score, by 16.7%). The decrease in habitat suitability is likely seasonally driven with lower base flows compared to the previous season.
- **Temporally at the downstream site**. No scores could be calculated for this assessment as the site was dry.
- **Spatial comparisons**. No scores could be calculated as the downstream site was dry at the time of the assessment. It is however deemed essential that reasons for the lack of flow at the downstream site are determined.

T4/5:

- **Temporally at the upstream site**, the SASS Total score decreased significantly by 46.8% and the ASPT score insignificantly by 11.3% between the baseline and the current (May 2025) assessment. The IHAS score insignificantly increased by 2.3% when compared to the baseline assessment. When compared to the previous season the SASS score decreased significantly by 70.9% whilst the ASPT score significantly decreased by 29%. However, the habitat suitability (IHAS) score increased by 17.6% when compared to the previous season (March 2024). The observed changes may be due to seasonal effects as well as as well as the impact of fire on the system.
- **Temporally at the downstream site**, the SASS and ASPT total score significantly decreased by 46% with a slight increase in the ASPT score by 12% when compared to the January 2024



assessment. Habitat suitability (IHAS score) decreased by 23% when compared to the baseline and likely contributed to the observed decrease in SASS score as measure of diversity. When compared to the previous assessment the SASS score, ASPT, and IHAS had decreased significantly by 49.6%, 3.6% and 22.5%, respectively. The observed reductions indicate the same catchment wider drivers of change affecting this site.

- **Spatially between the upstream and downstream sites**, a downstream significant improvement in both SASS5 (144%), IHAS (40.9%) and ASPT (33.1%) scores was noted. The significant downstream improvement in macro-invertebrate community diversity is likely due to the significant downstream increase in habitat suitability (40.9%) due to increased depth and flow as well as increased substrate diversity.

As per Figure 7 below which has plotted the SASS Total score (x-axis) against the ASPT (y-axis) within the context of Present Ecological Status (PES). Thresholds “biological bands” for an upper longitudinal profile river in the Southern Folded Mountains Ecoregion, the following inferences can be drawn.

- The HAV1 Replacement upstream site deteriorated from a PES Class A (Pristine) ecological condition to a PES Class B (Slight to moderately Modified) ecological condition between January 2024 and May 2025 due to a significant decrease in both the SASS5 and ASPT scores;
- The HAV1 Replacement downstream site’s ecological condition was a PES Class D (Largely Modified) ecological condition in January 2024, but could not be determined due to the site being dry during the May 2025 assessment;
- The T4/5 upstream site improved from a PES Class E/F (Severely to Critically Modified) to a PES Class D (Largely Modified) ecological condition between January 2024 and May 2025 assessment, likely due to the significantly increasing SASS5 score and slightly increasing ASPT score; and
- The T4/5 downstream site deteriorated from a PES Class C (Moderately Modified) to a PES Class E/F (Severely Modified) ecological condition between January 2024 and May 2025 assessment, likely due to the significantly decreasing SASS5 score and ASPT score.

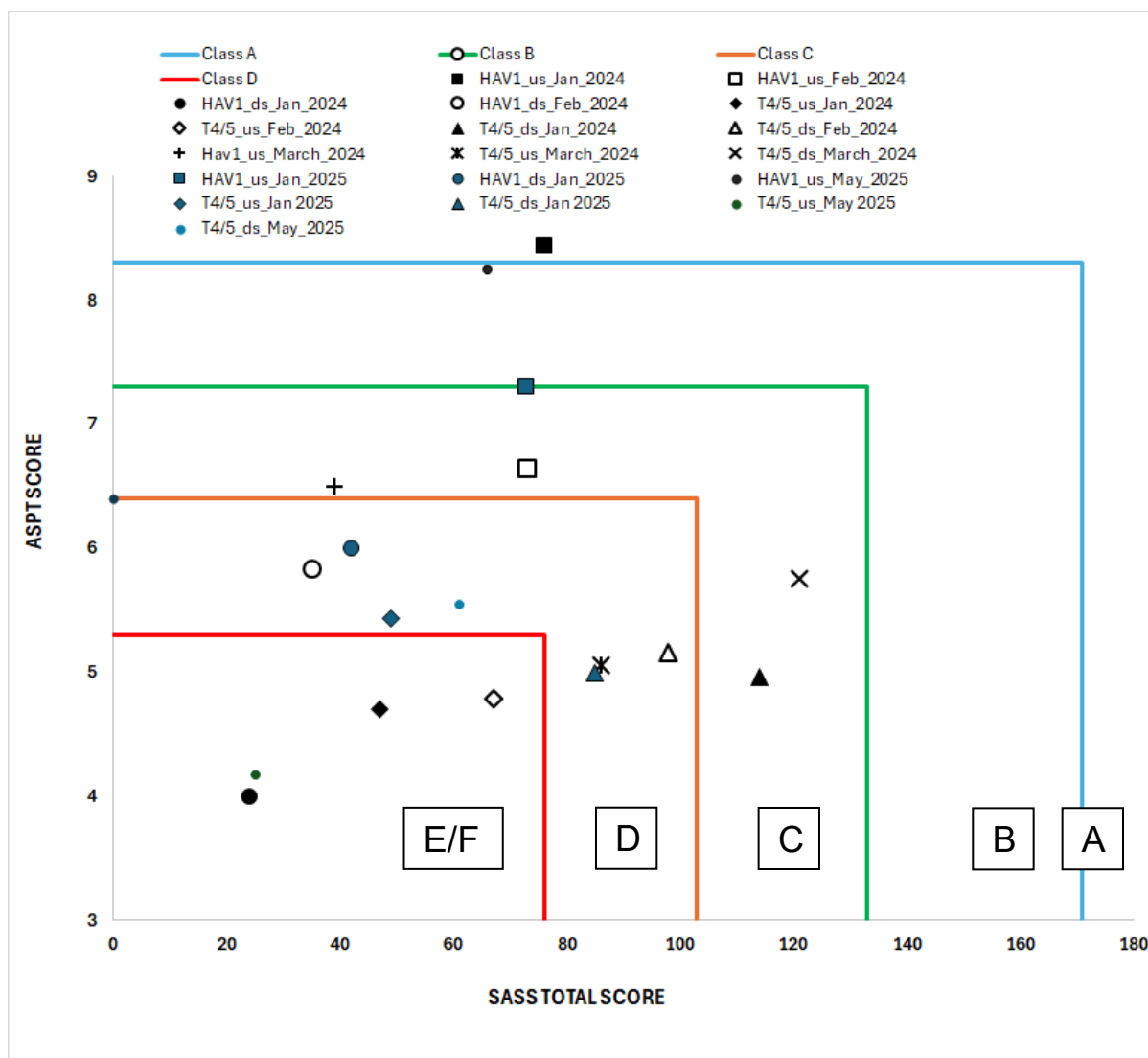
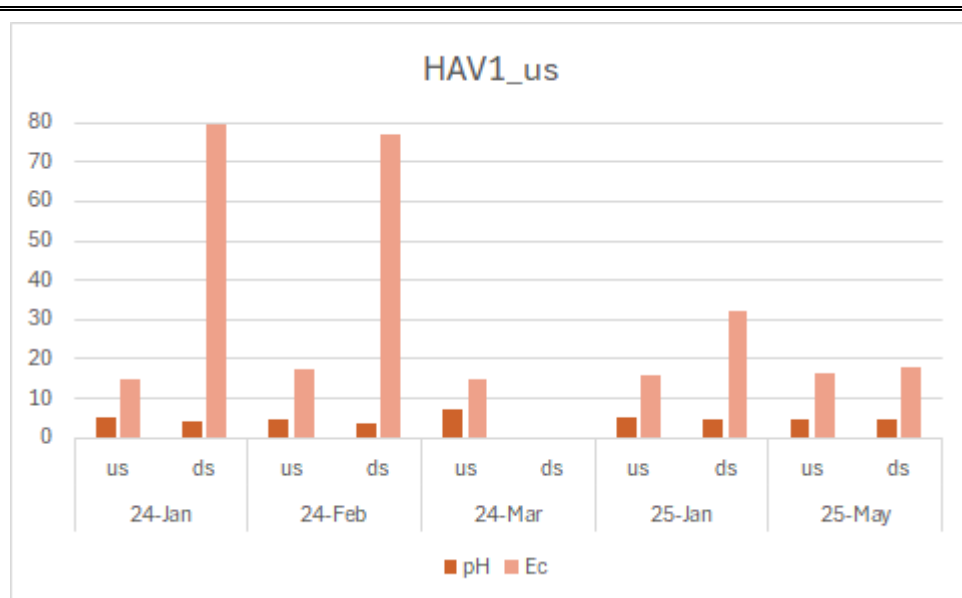


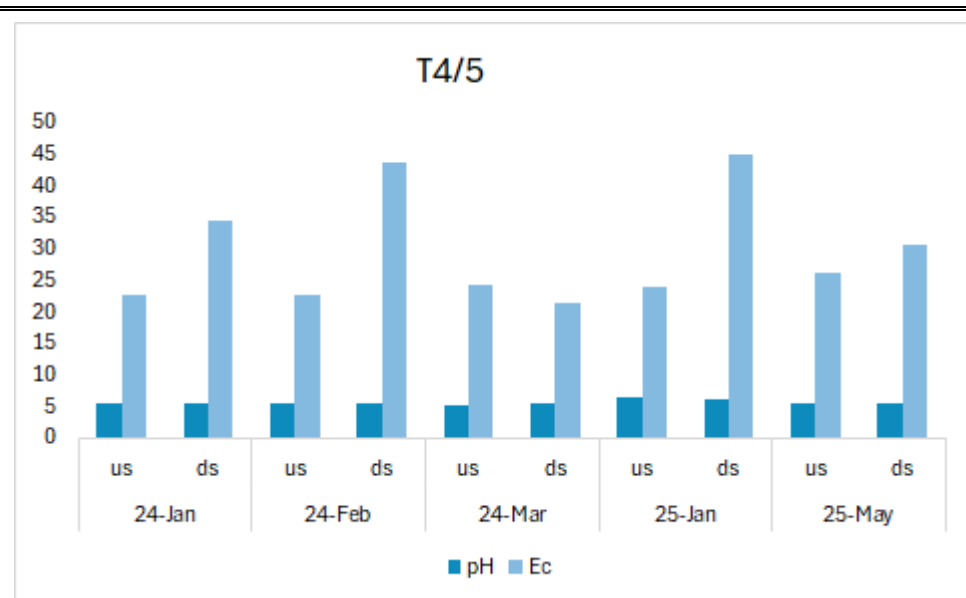
Figure 7: Scatterplots of the SASS total scores and ASPT scores within the context of their PES threshold scores as derived for an upper longitudinal profile river in the Southern Folded Mountains Ecoregion.

In Situ Physico-Chemistry

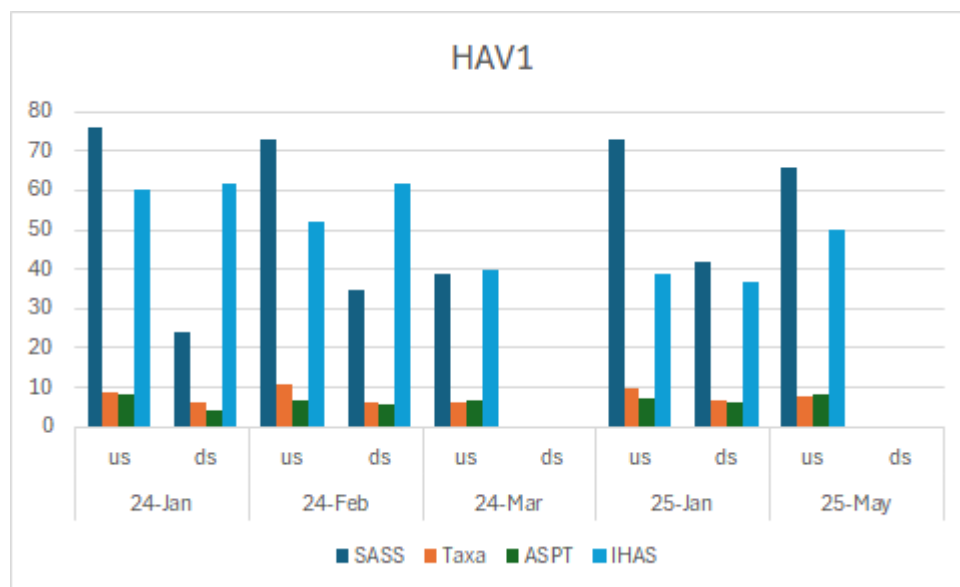
The measured pH and Electrical Conductivity (EC) for the HAV1 Replacement and T4/5 biomonitoring sites during the January, February, March 2024, January 2025, and May 2025 aquatic assessments are tabulated below in Table 4 and graphed below in Figure 8. The percentages in variation of the pH and EC at the HAV1 replacement and T4/5 biomonitoring sites were compared temporally and spatially in Table 6 below as well.

**Table 6: Spatial and temporal variations observed between site HAV1_us and HAV1_ds in May 2025.****Figure 8: Spatial and temporal water quality variation between site HAV1_us****Comment:**

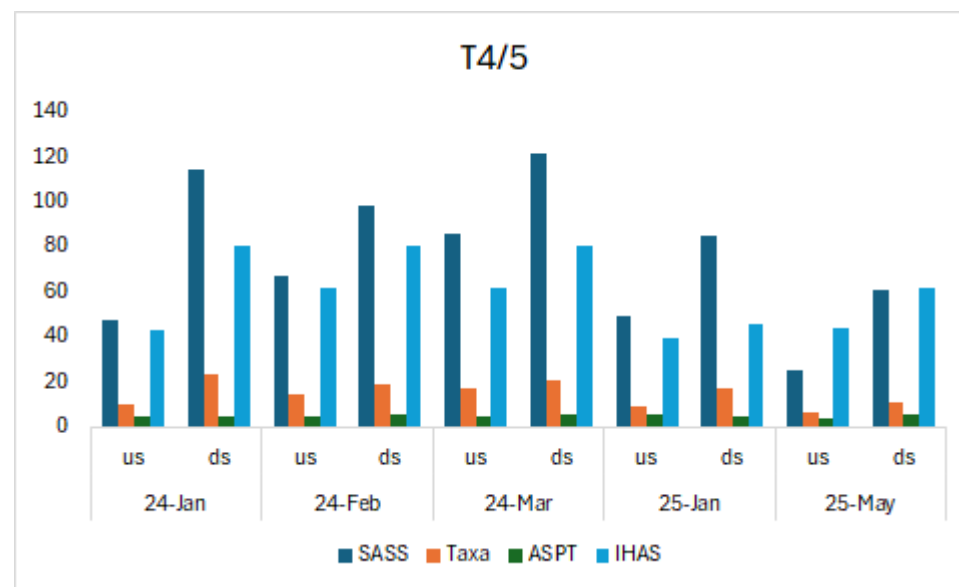
- Spatially, EC increased by 8.5% in a downstream direction and was considered an insignificant change and within natural variability ranges. The increase is possibly due to cumulative impacts from catchment-wide anthropogenic sources. Seasonal changes such as low rainfall and increased evaporation, potentially contributed to the downstream increase in EC;
- EC had increased by 10.7% when compared to the baseline (January 2024). Figure 8 shows the trend in EC to increase in a downstream direction in the long term which possibly indicates catchment-wide activities which impact the river in a downstream direction;
- The pH was below natural levels at all sites and is slightly acidic, a negative impact from pH on sensitive taxa at the time of the May 2025 assessment is anticipated. The pH decreased in a downstream direction during the May 2025 assessment which implicates a potential source of acidic contamination between the sites (although variation local geology could also be a contributing factor);
- **In conclusion:** The May 2025 assessment results revealed a spatial deterioration in both the measured pH and EC in a downstream direction. As noted before, the majority of environmental deterioration is likely due to catchment-wide impacts compounded by seasonal natural flow constraints and local geology (for pH); and
- Ongoing monitoring at these points will need to continue to monitor existing trends and identify any emerging trends.

**Figure 9: Spatial and temporal water quality variation between site T4/5****Comment:**

- Spatially, EC increased by 17.6% in a downstream direction and was considered a significant and negative change. The increase is likely due to cumulative impacts from catchment-wide anthropogenic sources. Seasonal changes such as low rainfall and increased evaporation, potentially contributed to the downstream increase in EC;
- EC had increased by 15.9% when compared to the baseline (January 2024). Figure 9 shows the trend in EC to increase in a downstream direction in the long term which possibly indicates sources of catchment-wide activities which impact the river in a downstream direction;
- The pH was considered slightly acidic and did not comply within natural levels at the upstream and downstream sites. This is seen as a negative impact at the time of the May 2025 assessment. Previous assessments show that pH remained largely stable;
- **In conclusion:** The May 2025 assessment results revealed a spatial deterioration in the measured EC in a downstream direction. As noted before, the majority of environmental deterioration is likely due to catchment-wide impacts compounded by seasonal natural flow constraints; and
- Ongoing monitoring at these points will need to continue to monitor existing trends and identify any emerging trends.

**Table 7: Spatial macro-invertebrate community integrity variation between site HAV1 and T4/5 in May 2025.****Figure 10: Spatial and temporal macro-invertebrate community integrity variation at HAV1****Comment:**

- Spatially, the macro-invertebrate community SASS and ASPT scores could not be calculated as no data could be captured for the downstream site as it was dry during the time of the May 2025 assessment;
- The macro-invertebrate habitat suitability was regarded as 'Poor' at the upstream site (HAV1 Replacement) according to the IHAS classification;
- **In conclusion:** Natural constraints such as low flow (to which increased evaporation contributes due to shallow conditions) with resulting low diversity of flow and habitat types are also likely to affect macro-invertebrate habitat distribution, diversity, and sensitivity scores at this site. Erosion with resulting sedimentation impact further limiting suitable macro-invertebrate habitat is also a possible negative potential contributor to the macro-invertebrate diversity at this site.
- it is deemed essential that the reason for the reduced flow between the two assessment points be determined

**Figure 11: Spatial and temporal macro-invertebrate community integrity variation at T4/5****Comment:**

- Spatially, the macro-invertebrate community integrity (SASS as measure of diversity) significantly increased in a downstream direction and remained consistent from a Category D (Largely Modified) at site T4/5_us to a Category D (Largely Modified) at site T4/5_ds.
- The macro-invertebrate habitat suitability was regarded as 'Poor' at the upstream site (T4/5_us) and Fair at the downstream site (T4/5_ds) according to the IHAS classification;
- Spatially, the macro-invertebrate community diversity (SASS5), Habitat suitability (IHAS) and ASPT scores increased in a downstream direction by 144%, 40.9%, and 33.1% respectively and in all instances;
- **In conclusion:** the improved community diversity and sensitivity at the downstream site can be ascribed to improved flow at this point. Some impacts on water quality at the downstream site may affect the aquatic community..



CONCLUSIONS

EC increased downstream by 8 – 18% at both downstream sites assessed, indicating a significant negative impact, likely due to dissolved ion accumulation and anthropogenic activities in the catchment. Seasonal influences (e.g. low rainfall, evaporation) contributed to the downstream EC increase. Compared to the January 2024 baseline assessment, EC increased by 10-16%, suggesting long-term increasing trends. pH was relatively low and was regarded as acidic, although this is natural in this environment. Overall, the May 2025 assessment showed deterioration, which is likely due to seasonal variation in flow and therefore largely natural. Habitat suitability was considered Poor from HAV_1 (upstream) and improved in a downstream direction from Poor to Fair for T4/5. Macroinvertebrate community diversity (SASS5), ASPT and Habitat suitability scores increased at site T4/5 by 144%, 33.1%, and 40.9%.

Given the very high erosive damage in the Hemel en Aarde catchment resulting from the 2024 winter rains, the streams and rivers in general are regarded as being outside of their normal biotic conditions, both from a habitat quality and water quality perspective. However, despite the above, concerns are raised with respect to significantly decreasing SASS5 and ASPT scores for the HAV1 Replacement upstream sites compared to the January 2024 assessment. The deterioration in macro-invertebrate community integrity is most likely due to significantly decreased habitat suitability and lack of flow. No points of concern are raised with respect to the macro-invertebrate community and the associated habitat during the pre-construction phase of the pumphouse and pipelines for the T4/5 boreholes. The HAV1 “replacement” system may be affecting instream flow and this aspect should be investigated further.

RECOMMENDATIONS

- The potential erosion and siltation of streams must be continuously monitored in parallel with the SASS5 biomonitoring assessment, to ensure that the interstitial spaces of the streams, that are used as refugia for eggs and small/juvenile specimens, remain unclogged.
- Consideration should be given to instream flow monitoring of the systems with data monitored and assessed both spatially and temporally to determine if any impacts on the systems are occurring as a result of groundwater abstraction.
- In the event that the flows dry up to the degree that the SASS5 protocol can no longer be applied, the monitoring programme would need to be adjusted to accommodate the use of diatom and habitat indices that are appropriate under very low to zero flow environmental conditions.
- It is recommended that monitoring continues to identify long term trends by building a database and impacts on the Hemel en Aarde catchment.
- Land-use assessments are recommended to identify catchment-wide activities possibly contributing to the increased EC in a downstream direction.
- Promote the growth of riparian vegetation restoration to stabilize banks, reduce runoff and deposition into the river, and improve habitat conditions for macro-invertebrates.



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APPENDIX A – SASS5 Sheets

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET - MAY 2025

DATE: 22/05/2025	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	PORIFERA	5					HEMIPTERA:						DIPTERA:					
S: °	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E: °	TURBELLARIA	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: T4/5 Upstream	ANNELIDA:						Gerridae*	5		1		1	Ceratopogonidae	5				
RIVER:	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2			1	1
SITE DESCRIPTION:	Leeches	3					Nauconidae*	7					Culicidae*	1				
WEATHER CONDITION:	CRUSTACEA:						Nepidae*	3					Dixidae*	10				
TEMP: 21,3 ° C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 5,51	Potamonautidae*	3					Pleidae*	4					Ephyridae	3				
DO: 1,13 mg/l 16,2%	Atyidae	8					Veliidae/M... veliidae*	5		A		A	Muscidae	1				
Cond: 262 mg/L	Palaemonidae	10					MEGALOPTERA:						Psychodidae	1				
BIOTOPES SAMPLED:	HYDRACARINA	8					Cordalidae	8					Simuliidae	5				
SIC: TIME: minutes	PLECOPTERA:						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1 sp	4					Hydropsychidae 1 sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocn.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					SASS SCORE:		0	23	7	25
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		0	5	2	6
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		####	4,60	3,50	4,17
	Chlorolestidae	8					Pisuliidae	10					IHAS:		%			
	Coenagrionidae	4		A		A	Sericostomatidae SWC	13					OTHER BIOTA:					
	Lestidae	8					COLEOPTERA:											
SIGNS OF POLLUTION:	Platynemidae	10					Dytiscidae*	5		A	A	B	COMMENTS:					
	Protoneuridae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5					SWC = South Western Cape					
	Aeshnidae	8					Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8					S = Stone & rock					
	Libellulidae	4		A		A	Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					



RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET																		
DATE: 22/05/2025	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	PORIFERA	5					HEMIPTERA:						DIPTERA:					
S: °	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E: °	TURBELLARIA	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: T4/5 Downstream	ANNELIDA:						Gerridae*	5					Ceratopogonidae	5				
RIVER:	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2		A		A
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	CRUSTACEA:						Nepidae*	3					Dixidae*	10				
TEMP: 21,2 ° C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 5,54	Potamonautidae*	3	1			1	Pleidae*	4					Ephydriidae	3				
DO: 6,22 mg/l 67,6%	Atyidae	8					Veliidae/M...veliidae*	5					Muscidae	1				
Cond: 308 mg/L	Palaemonidae	10					MEGALOPTERA:						Psychodidae	1				
BIOTOPES SAMPLED:	HYDRACARINA	8					Cordalidae	8					Simuliidae	5	A	A		A
SIC: TIME: minutes	PLECOPTERA:						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1 sp	4					Hydropsychidae 1 sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9	1			1	CASED CADDIS:						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13	1	1		A	Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					SASS SCORE:		46	39	0	61
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		7	7	0	11
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		6,57	5,57	####	5,55
	Chlorolestidae	8					Pisuliidae	10					IHAS:		%			
	Coenagrionidae	4		1		1	Sericostomatidae SWC	13					OTHER BIOTA:					
	Lestidae	8					COLEOPTERA:											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5		1		1	COMMENTS:					
	Protoneuridae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5	1			1	SWC = South Western Cape					
	Aeshnidae	8					Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6	A	1		A	Hydraenidae*	8					S = Stone & rock					
	Libellulidae	4		A		A	Hydrophilidae*	5	A			A	VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					



RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET																		
DATE: 22/05/2025	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	PORIFERA	5					HEMIPTERA:						DIPTERA:					
S: °	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E: °	TURBELLARIA	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: HAV1/US	ANNELIDA:						Gerridae*	5					Ceratopogonidae	5				
RIVER:	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2				
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	CRUSTACEA:						Nepidae*	3					Dixidae*	10				
TEMP: 21,4 ° C	Amphipoda	13			B	B	Notonectidae*	3					Empididae	6				
Ph: 4,94	Potamonautidae*	3			A	A	Pleidae*	4					Ephydriidae	3				
DO: 5,83 mg/l 65%	Atyidae	8					Veliidae/M...veliidae*	5					Muscidae	1				
Cond: 165 mg/L	Palaemonidae	10					MEGALOPTERA:						Psychodidae	1				
BIOTOPES SAMPLED:	HYDRACARINA	8					Cordallidae	8					Simuliidae	5				
SIC: TIME: minutes	PLECOPTERA:						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1 sp	4					Hydropsychidae 1 sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10			1	1	Lymnaeidae*	3				
MUD:	Ephemeraidae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13			A	A	Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					SASS SCORE:		0	0	66	66
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6			B	B	NO OF TAXA:		0	0	8	8
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		####	####	8,25	8,25
	Chlorolestidae	8					Pisuliidae	10					IHAS:		%			
	Coenagrionidae	4			1	1	Sericostomatidae SWC	13					OTHER BIOTA:					
	Lestidae	8					COLEOPTERA:											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5			A	A	COMMENTS:					
	Protoneuridae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5					SWC = South Western Cape					
	Aeshnidae	8					Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12			A	A	ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8					S = Stone & rock					
	Libellulidae	4					Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					



APPENDIX B – IHAS Sheets

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name: Seasonal Stream of the Onrus River						
Site Name: HAV1 Replacement Upstream	Date: 22 MAY 2025					
SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min) (* NOTE: up to 25% of stone is usually embedded in the stream bottom)	0	<1	>1-2	2	>2-3	>3
SIC Score (max 20):						0
VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none		1-25	26-50	51-75	>75
Vegetation Score (max 15):						5
OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time) (** NOTE: you must still fill in the SIC section)		under		corr		over
Other Habitat Score (max 20):						14
HABITAT TOTAL (MAX 55):						19
STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>1	1	>½-1	½	<½-¼	<¼
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	50-80	81-95	>95		
(** NOTE: if more than one option, choose the lowest)						
STREAM CONDITIONS TOTAL (MAX 45):						31
TOTAL IHAS SCORE (%):						50



INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name: Perennial stream of the Onrus River						
Site Name: T4/5 upstream	Date: 22 May 2025					
SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min) (* NOTE: up to 25% of stone is usually embedded in the stream bottom)	0	<1	>1-2	2	>2-3	>3
SIC Score (max 20):			0			
VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none		1-25	26-50	51-75	>75
Vegetation Score (max 15):			10			
OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
Other Habitat Score (max 20):			10			
HABITAT TOTAL (MAX 55):			20			
STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>1	1	>½-1	½	<½-¼	<¼
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	50-80	81-95	>95		
STREAM CONDITIONS TOTAL (MAX 45):			24			
TOTAL IHAS SCORE (%):			44			



INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name: Perennial stream of the Onrus River						
Site Name: T4/5 Downstream	Date: 22 May 2025					
SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min) (* NOTE: up to 25% of stone is usually embedded in the stream bottom)	0	<1	>1-2	2	>2-3	>3
SIC Score (max 20):			10			
VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none		1-25	26-50	51-75	>75
Vegetation Score (max 15):			7			
OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
Other Habitat Score (max 20):			10			
HABITAT TOTAL (MAX 55):			27			
STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>1	1	>½-1	½	<½-¼	<¼
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	50-80	81-95	>95		
STREAM CONDITIONS TOTAL (MAX 45):			35			
TOTAL IHAS SCORE (%):			62			



Name: Rudolf Gouws
Date: Thursday, 13 November 2025
Ref: FEN 25-5003

Umvoto Africa (Pty) Ltd
8 Beach Road
Muizenberg
Cape Town
7945
Tel: +27 (0) 21 709 6700
Attention: Gemma Bluff

TECHNICAL MEMORANDUM

RE: THE SASS5 BIOMONITORING RESULTS OF THE RIVER REACHES THAT MAY POTENTIALLY BE IMPACTED AS PART OF THE DEVELOPMENT OF THE HAV1 "REPLACEMENT" AND T4/5 PRODUCTION BOREHOLES, HEMEL EN AARDE WELLFIELD, OVERSTRAND MUNICIPALITY, HERMANUS.





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INTRODUCTION

Freshwater Ecologist Network (FEN) (Pty) Ltd was appointed by Umvoto Africa (Pty) Ltd to undertake the rapid South African Scoring System Version 5 (SASS5) (Dickens and Graham 2002) biomonitoring field assessment on river reaches that may potentially be contaminated as a result of activities related to the construction of the pumphouse and pipelines for both the HAV1 “replacement” and T4/5 boreholes.

The Overstrand Local Municipality has been issued a WUL (No. 18/G40H/A/2377) under Section 21(c) and (i) of the National Water Act (36 of 1998) for production boreholes HAV1 Repl. and T4/5 during pumphouse construction, borehole equipping, and pipeline construction. This WUL requires the following:

A bio-monitoring programme (SASS) must be implemented along the affected length of the watercourse/s and must include a habitat assessment.

Umvoto Africa has requested three (3) sets [1 pre-construction (conducted in January 2025), 1 during construction (22nd of May 2025), 1 post-construction (3rd September 2025)] of rapid SASS5 monitoring of a single upstream and single downstream site for each of the HAV1 Repl. and T4/5 borehole sites.

The location of these sites is provided below in Figure 1.

Biomonitoring has taken place on the 19th of January 2024, 22nd of February 2024, and 28th of March 2024 as part of the borehole drilling phase, on the 14th of January 2025, 22nd of May 2025 and September 2025 on river reaches that are upstream and downstream of the proposed pumphouse and pipelines construction activities. The January 2024 data is representative of baseline conditions prior to borehole development and the February 2024 and March 2024 data is representative of the construction phase for both boreholes. Borehole development includes the discharge of natural groundwater into temporary sumps (stilling basins) which remove sediment out of suspension, after which the groundwater will be discharged via temporary PVC pipelines/existing channels into an area of low sensitivity in a controlled/erosion preventative manner, eventually finding its way into the receiving downgradient watercourse.

METHODS

SASS5 was developed for assessing river water quality and river health based on the assemblage of aquatic macro-invertebrates identified amongst stoney, vegetation, and gravel, sand and mud (GSM) biotopes at a given river reach. Each macro-invertebrate is assigned a SASS5 sensitivity score that ranges from 1-15 which is indicative of the degree of tolerance to deteriorating water quality, with a score of 1 indicating highly tolerant, and a score of 15, highly intolerant. The sensitivity scores of the identified taxa (families and orders) are summed per biotope and the sum of all taxa observed across all biotopes calculates the SASS score, when this score per biotope as well as the total SASS score is divided by the number of different taxa observed in that biotope the Average Score Per Taxon (ASPT) can be calculated - the average sensitivity of aquatic macro-invertebrates per biotope. The SASS5 score and ASPT gives an indication of community sensitivity and diversity and any changes in these aspects can indicate an improving or deteriorating environment.

The competencies of the SASS rapid field based biomonitoring technique include the following:

- Assessing the ecological state of aquatic ecosystems;
- Assessing the spatial and temporal trends in ecological state;
- Assessing emerging problems;
- Setting objectives for rivers;
- Assessing the impact of developments;



- Predicting changes in the ecosystems due to developments;
- Contributing to the determination of the Ecological Reserve as part of the National Water Act (Act 36 of 1998), as amended.

The biomonitoring assessment included the following aquatic indices:

- Invertebrate Habitat Assessment System (IHAS) - McMillan (1998) which was informed by a survey of general habitat integrity to evaluate the suitability of habitat conditions in allowing for a diverse community of aquatic macro-invertebrates;
- South African Scoring System Version 5 (SASS 5) – which derives the Present Ecological Status (PES) of a river based on the presence of macro-invertebrate families; and
- *In situ* biota specific water quality data was collected to assist in interpreting the biological data, using a calibrated portable multimeter (ExStik II).

All work was conducted and/or overseen by a South African River Health Program (SA RHP) SASS5 Accredited Assessor.

Please refer to Figure 1 for the locality map of the sampling sites.

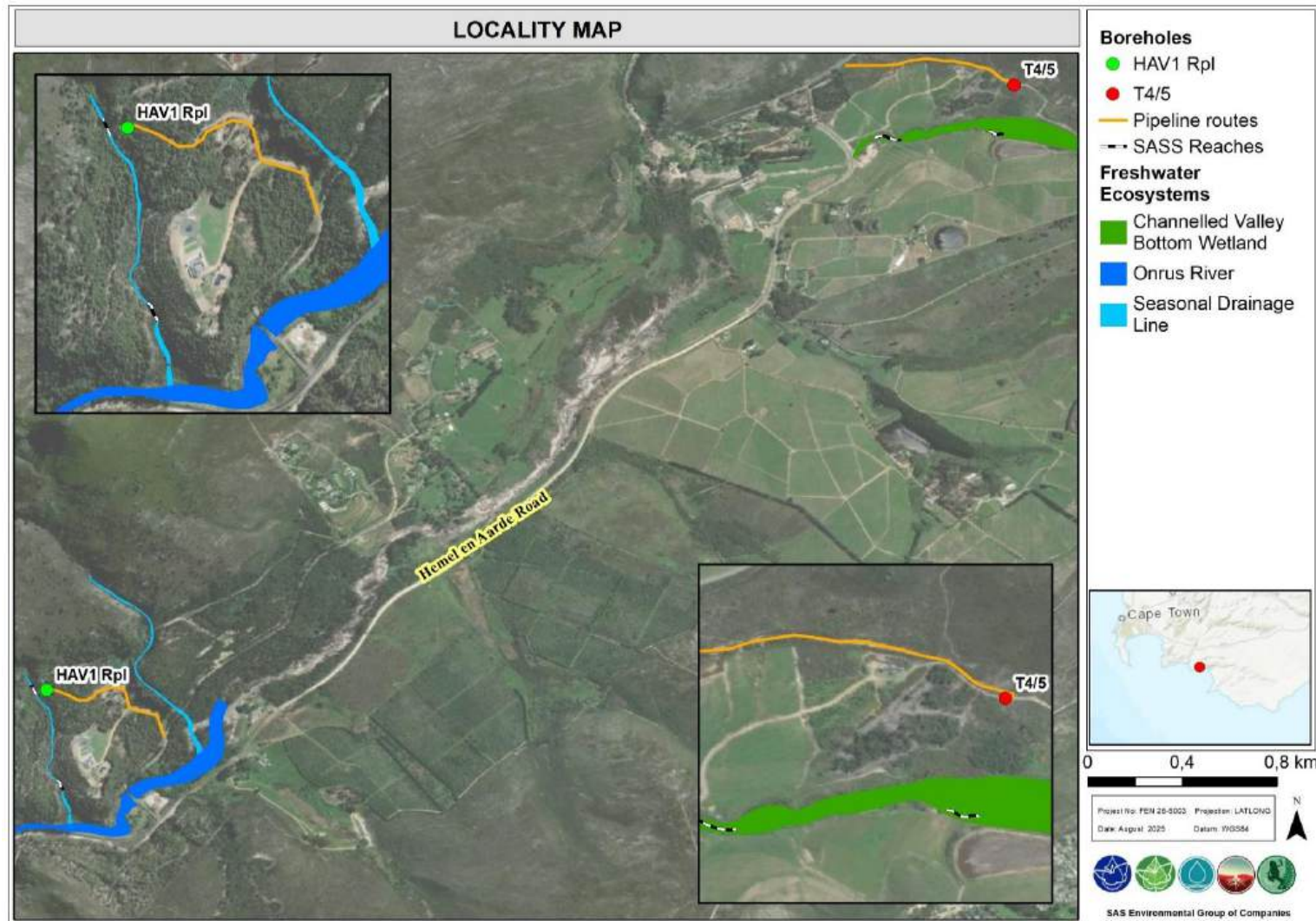


Figure 1: Location of the HAV1 replacement and T4/5 SASS5 sampling reaches in relation to the proposed pipeline routes.



RESULTS

Site Descriptions

HAV1 replacement (upstream): This closed-canopied seasonal mountain stream is a clear light brown (tannin enriched) colour which is < 1 m wide and ~ 0.15 m deep. A slow shallow run dominated the hydraulic biotope habitat, with occasional shallow pools observed. This stream has had its hydrological budget, marginal and vegetation composition significantly impacted by historic and ongoing *Eucalyptus* tree (Blue Gum) afforestation practices, and subsequent invasion by several *Acacia* (wattle) species. The dominant indigenous marginal vegetation was *Ficinia capillifolium*. Parts of the stream reach were buried underneath alien vegetation debris, and it is envisaged that continued alien invasive vegetation clearing (as observed) will increase the rainfall catchment yield available to this stream, which would increase the hydroperiod and ability of this stream to support a larger vegetation community in future. The water quality of this stream is considered good, despite organic input almost entirely from alien invasive vegetation.

HAV1 replacement (downstream): The overall vegetation community remained dominated by alien and invasive vegetation.

T4/5 (upstream): This river reach within a larger channelled valley bottom wetland had recently undergone large scale erosion, and as a result much of the riverine habitat had been lost. The river further upstream was observed to be in a zero flow condition, and therefore it is suspected that the discharge at this site is likely being supplemented by impoundment seepage or other lateral interflow processes. The stream active channel was ~1 m wide and < 0.1 m deep, was clear and dominated by sand and mud biotopes. The hydrological profile of the stream reach was a barely perceptible run. Disturbance of this river bed has allowed for the dominance by pioneering species such as *Pteridium aquilinum* (Bracken fern) and the water quality is considered good.

T4/5 (downstream): This downstream river reach, by comparison, accommodated a much more diverse SASS5 sampling habitat consisting of runs, riffles, pools, and backwaters. Discharge at this site was significantly greater compared to the upstream site, with the river being ~ 1.5 m wide and 0.2 m deep. Although erosion was still very evident at this site, the marginal vegetation out of current was still intact, which provided a good SASS vegetation sampling habitat. Visually the water quality improved significantly at this site and was a clear light brown colour and is considered to be of a very good quality. As with previous assessments, the hydraulic biotopes were regarded as good. Cobbles at the site become increasingly covered with organic material and is likely due to a general decrease in baseflows over the summer season.

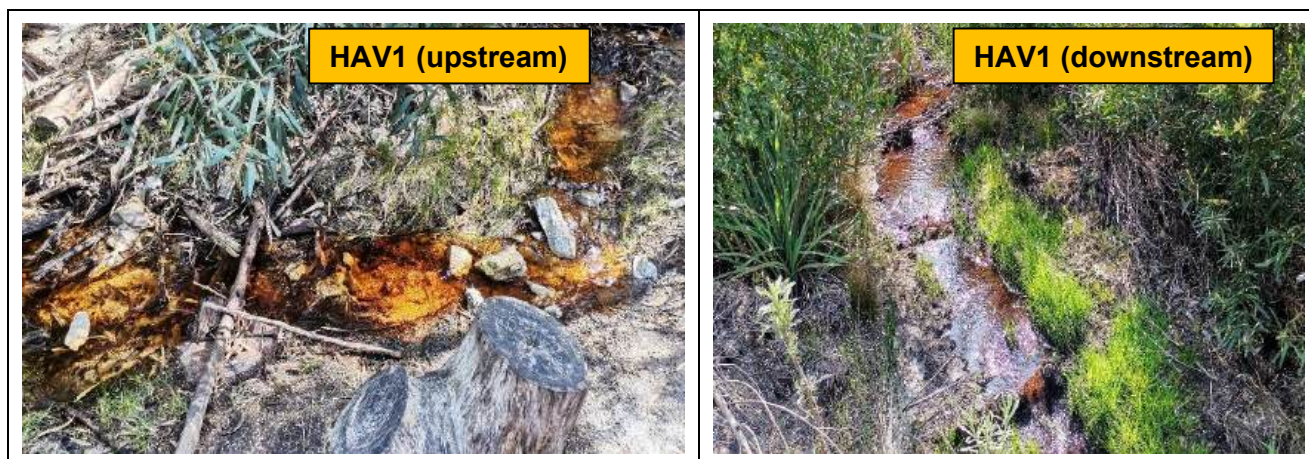




Figure 2: River reaches sampled upstream and downstream of the HAV1 Replacement and T4/5 production borehole locations.

During the September 2025 assessment, four biomonitoring sites (Upstream [HAV1 Replacement] and Downstream [HAV1 Replacement], along with the upstream [T4/5] and downstream [T4/5]) located on the rivers were assessed. The spatial and temporal evaluation was applied to both sites where applicable.

Results are presented as “dashboard style” reports (Tables 1 to 7). These dashboard reports aim to present concise summaries of the data on as few pages as possible, to allow for integration of results by the reader. Where required, further discussion and interpretation is provided.

**Table 1: Results of the assessment at site HAV1 Replacement (located upstream) of the Hemel en Aarde catchment.**

Site HAV1 (US)		In situ physico-chemical water quality				Aquatic macro-invertebrate community integrity			
	Parameter	Sept 2025	Site specific spatial water quality variations (% var)		Parameter	Sept 2025	Site specific spatial aquatic invertebrate community variations (% var) from:		
			Parameter	From upstream spatial reference			Parameter	Upstream spatial reference	
	pH	4.54	pH	NA	SASS5 score	71	SASS5	NA (No upstream spatial reference)	
	EC (mS/m)	15.4	EC	(No upstream spatial reference)	Number of taxa	8	ASPT		
	Temp (°C)	18.2	Temp		ASPT score	8.88	IHAS		
	Site specific temporal water quality percentage variations (% var):				Site specific temporal aquatic invertebrate community variations (% var)				
Parameter	From previous assessment (May 2025)	From baseline (January 2024)	Parameter	From previous assessment (May 2025)	From baseline (January 2024)				
pH	-8.1	-13.2	SASS5	+7.6	-6.6				
EC (mS/m)	-6.7	+3.4	ASPT	+7.6	+5.2				
			IHAS	-4.0	-20.0				
Key for spatial and temporal water quality and macro-invertebrate comparisons: Negative value = decrease; Positive value = increase; Normal text = no significant change; Bold text = significant change (compared to guideline); Red text = significant deterioration; Blue text = significant improvement.									
Visual assessment and site description			Key drivers of system change: <u>Water quality:</u> pH was considered slightly acidic and did not comply with the RWQO of South Africa [(6.5 – 8.4) DWA, 2011]. However, this is not uncommon in areas of the Western Cape that tend to have a naturally lower pH level due to geology. EC was considered low and ideal (<30 mS/m), and insignificantly lower compared to the previous monitoring season (May 2025) and insignificantly higher baseline assessment (January 2024). <u>Macro-invertebrate habitat score (IHAS)</u> has decreased insignificantly compared to the previous assessment and decreased significantly compared to the baseline. The <u>macro-invertebrate diversity (SASS5)</u> scores (measure of diversity) have insignificantly increased when compared to the previous assessment. <u>ASPT score</u> (measure of sensitivity) has increased insignificantly over the same period. Natural constraints such as limited depth and flow (to which increased evaporation contributes due to shallow conditions), with resulting low diversity of flow and habitat/substrate types, as well as temporal variation of the surface water levels (perennial nature of the stream) are also likely to affect macro-invertebrate habitat distribution, diversity, and sensitivity scores at this site.						
Algal proliferation	None observed on site.								
Depth	Mostly dominated by shallow pools and runs (average depth <1/4 meter).								
Flow condition	Very slow								
Riparian zone characteristics	The riparian zone is dominated by grasses as well as <i>Eucalyptus</i> sp. and wattle sp.								
Water clarity and odour	Clear at time of assessment. No odour present.								
SITE ECOSTATUS CATEGORY									
Variable			Category/ Classification						
SASS5 (Dallas)			A (Largely Natural)						

**Table 2: Results of the assessment at site HAV1 Replacement (located downstream) of the Hemel en Aarde catchment.**

Site HAV1 (DS)		In situ physico-chemical water quality				Aquatic macro-invertebrate community integrity			
	Parameter	Sept 2025	Site specific spatial water quality variations (% var)		Parameter	Sept 2025	Site specific spatial aquatic invertebrate community variations (% var) from:		
			Parameter	From upstream spatial reference			Parameter	Upstream spatial reference	
	pH	4.33	pH	-4.6	SASS5 score	56	SASS5	-21.0	
	EC (mS/m)	19.0	EC	+23.4	Number of taxa	7	ASPT	-10.0	
	Temp (°C)	18.2	Temp	N/A	ASPT score	8.00	IHAS	0.0	
	IHAS score				IHAS score	48			
Site specific temporal water quality percentage variations (% var):					Site specific temporal aquatic invertebrate community variations (% var)				
Parameter	From previous assessment (May 2025)		From baseline (Jan 2024)		Parameter	From previous assessment (May 2025)		From baseline (Jan 2024)	
pH	Dry		+5.4 -76.1		SASS5	Dry		+133.3	
EC (mS/m)					ASPT			+100.0	
					IHAS			-22.6	
Key for spatial and temporal water quality and macro-invertebrate comparisons: Negative value = decrease; Positive value = increase; Normal text = no significant change; Bold text = significant change (compared to guideline); Red text = significant deterioration; Blue text = significant improvement.									
Visual assessment and site description					Key drivers of system change: <u>Water quality:</u> pH was considered slightly acidic and did not comply with the RWQO of South Africa [(6.5 – 8.4) DWA, 2011]. However, this is not uncommon in areas of the Western Cape that tend to have a naturally lower pH level due to geology. EC was considered low and ideal (<30 mS/m) and significantly lower compared to the baseline assessment (January 2024). The reported pH value was significantly lower and EC concentration insignificantly higher compared to that of the upstream reference site. The macro-invertebrate diversity (SASS5) scores (measure of diversity) and ASPT score (measure of sensitivity) have significantly increased when compared to the baseline assessment (January 2024). Natural constraints such as limited depth and flow (to which increased evaporation contributes due to shallow conditions), with resulting low diversity of flow and habitat/substrate types, as well as temporal variation of the surface water levels (perennial nature of the stream) are also likely to affect macro-invertebrate habitat distribution, diversity, and sensitivity scores at this site. Impacts and Essential Mitigation: Impacts from seasonal increased flow velocity on the downstream site of the river is clearly visible by the erosion on the banks (Figure 4) which impacts macro-invertebrate diversity and abundances. The slightly elevated EC supports this and is seen as catchment wide impacts on the system.				
Algal proliferation	None observed on site.								
Depth	Mostly dominated by shallow pools (average depth <1/4 meter).								
Flow condition	Slow								
Riparian zone characteristics	The riparian zone is dominated by some grasses but mostly sediment deposits on the banks.								
Water clarity and odour	Sediment deposition on the banks is a contributor to the opaque water clarity and discolouration. No odours present.								
SITE ECOSTATUS CATEGORY									
Variable					Category/ Classification				
SASS5 (Dallas)					B (Largely Natural)				

**Table 3: Results of the assessment at site T4/5 (located upstream) of the Hemel en Aarde catchment.**

Site T4/5 (US)		In situ physico-chemical water quality				Aquatic macro-invertebrate community integrity			
	Parameter	Sept 2025	Site specific spatial water quality variations (% var)		Parameter	Sept 2025	Site specific spatial aquatic invertebrate community variations (% var) from:		
			Parameter	From upstream spatial reference			Parameter	Upstream spatial reference	
	pH	4.65	pH	NA	SASS5 score	94	SASS5	NA (No upstream spatial reference)	
	EC (mS/m)	20.9	EC	(No upstream spatial reference)	Number of taxa	15	ASPT		
	Temp (°C)	15.8	Temp		IHAS score	6.27	IHAS		
Site specific temporal water quality percentage variations (% var):					Site specific temporal aquatic invertebrate community variations (% var)				
Parameter	From previous season (May 2025)		From baseline (Jan 2024)		Parameter	From previous season (May 2025)		From baseline (Jan 2024)	
pH	-15.6		-17.7		SASS5	+276.0		+100.0	
EC (mS/m)	-20.2		-7.5		ASPT	+50.4		+33.4	
					IHAS	+15.9		+18.6	
Key for spatial and temporal water quality and macro-invertebrate comparisons: Negative value = decrease; Positive value = increase; Normal text = no significant change; Bold text = significant change (compared to guideline); Red text = significant deterioration; Blue text = significant improvement.									
Visual assessment and site description					Key drivers of system change: <u>Water quality:</u> pH was considered slightly acidic and did not comply with the RWQO of South Africa [(6.5 – 8.4) DWA, 2011]. pH was significantly lower compared to the baseline assessment and to the previous monitoring assessment. EC was considered within the normal range (<30 mS/m), and slightly lower compared to the baseline assessment (January 2024) and significantly lower when compared to previous season. <u>Macro-invertebrate habitat score (IHAS)</u> has increased significantly compared to the previous and baseline assessment by 15.9% and 18.6% respectively potentially contributing to the significant increase observed in the macro-invertebrate diversity (SASS) scores over the same periods (276.0% and 100.0%). The <u>ASPT score</u> has increased significantly compared to the previous assessment (May 2025) and increased significantly compared to the baseline assessment of January 2024 (both seen as a positive change). <u>Natural constraints</u> such as low flow (to which increased evaporation contributes due to shallow conditions) with resulting low diversity of flow and habitat types are also likely to affect macro-invertebrate habitat distribution, diversity, and sensitivity scores at this site.				
Algal proliferation	None observed on site.								
Depth	Mostly dominated by shallow pools (average depth <1/4 meter).								
Flow condition	Slow								
Riparian zone characteristics	The riparian zone is dominated by reeds and grasses.								
Water clarity and odour	Clear at the time of assessment. No odours present.								
SITE ECOSTATUS CATEGORY									
Variable					Category/ Classification				
SASS5 (Dallas)					D (Moderately Modified)				

**Table 4: Results of the assessment at site T4/5 (located downstream) of the Hemel en Aarde catchment.**

Site T4/5 (DS)		In situ physico-chemical water quality				Aquatic macro-invertebrate community integrity			
	Parameter	Sept 2025	Site specific spatial water quality variations (% var)		Parameter	Sept 2025	Site specific spatial aquatic invertebrate community variations (% var) from:		
			Parameter	From upstream spatial reference			Parameter	Upstream spatial reference	
	pH	4.43	pH	-4.7	SASS5 score	53	SASS5	-43.6	
	EC (mS/m)	22.6	EC	+8.1	Number of taxa	10	ASPT	-15.5	
	Temp (°C)	16.9	Temp	N/A	ASPT score	5.30	IHAS	+33.3	
	IHAS score	68							
Site specific temporal water quality percentage variations (% var):				Site specific temporal aquatic invertebrate community variations (% var)					
Parameter	From previous season (May 2025)		From baseline (Jan 2024)		Parameter	From previous season (May 2025)		From baseline (Jan 2024)	
pH	-20.0		-19.9		SASS5	-13.1		-53.5	
EC (mS/m)	-26.6		-34.5		ASPT	-4.5		+6.9	
					IHAS	+9.7		-15.0	
Key for spatial and temporal water quality and macro-invertebrate comparisons: Negative value = decrease; Positive value = increase; Normal text = no significant change; Bold text = significant change (compared to guideline); Red text = significant deterioration; Blue text = significant improvement.									
Visual assessment and site description					Key drivers of system change:				
Algal proliferation	None observed.				Water quality: Water quality: pH was considered slightly acidic and did not comply with the RWQO of South Africa [(6.5 – 8.4) DWA, 2011]. However, this is not uncommon in areas of the Western Cape that tend to have a naturally lower pH level due to geology. EC was considered within the normal range (<30 mS/m), and significantly lower compared to the baseline assessment (January 2024). pH was insignificantly lower (4.7%) and EC were insignificantly higher (8.1%) compared to the upstream reference. Macro-invertebrate habitat score (IHAS) has increased insignificantly and decreased significantly compared to the previous assessment (9.7%) and the baseline (15.0%), potentially contributing to the decrease observed in the macro-invertebrate diversity (SASS5) scores over the same periods (13.1% and 53.5%, respectively). ASPT score has decreased insignificantly compared to the previous assessment (4.5%) and increased slightly when compared to the baseline assessment (6.9%). The ASPT and SASS scores have decreased significantly when compared to the upstream site by 15.5% and 43.6% respectively despite the significant increase in habitat availability, and this is seen as a negative change.				
Depth	Mostly dominated by shallow pools and runs (average depth <1/4 meter).								
Flow condition	Still to slow flowing								
Riparian zone characteristics	The riparian zone is dominated by reeds and grasses.								
Water clarity and odour	Clear at time of assessment. No odour present.								
SITE ECOSTATUS CATEGORY									
Variable					Category/ Classification				
SASS5 (Dallas)					D (Largely modified)				

**Table 5: Aquatic macro-invertebrate community comparisons at the HAV1 Replacement and T4/5 biomonitoring sites since January 2024.**

		Jan-24	Feb-24	Mar-24	Jan-25	May-25	Sept-25	Jan-24	Feb-24	Mar-24	25-Jan	May-25	Sept-25	Jan-24	Feb-24	Mar-24	Jan-25	May-25	Sept-25	Jan-24	Feb-24	Mar-24	25-Jan	May-25	Sept-25
FAMILY	SENSITIVITY SCORE	HAV1 (us)						HAV1 (ds)						T4/5 (us)						T4/5 (ds)					
Oligochaeta	1																								
Amphipoda	13	✓	✓	✓	✓	✓	✓	✓							✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Potamonautidae*	3	✓	✓	✓	✓	✓	✓								✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Notonemouridae	14	✓					✓							✓			✓			✓					✓
Baetidae 1 sp.	4				✓									✓	✓	✓			✓						✓
Baetidae 2 sp.	6						✓								✓	✓			✓	✓	✓				
Leptophlebiidae	9																								
Caenidae	6														✓	✓			✓	✓			✓		
Chlorolestidae	8	✓	✓																						
Coenagrionidae	4				✓	✓									✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
Platycnemidae	10		✓																						
Aeshnidae	8														✓	✓	✓			✓	✓	✓			
Gomphidae	6							✓												✓	✓		✓	✓	
Libellulidae	4		✓	✓											✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Corixidae*	3							✓							✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Gerridae*	5		✓												✓	✓	✓	✓	✓	✓	✓	✓			
Hydrometridae*	6																			✓					✓
Neptidae*	3														✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Notonectidae	3																			✓					
Psephenidae*	4														✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	
Velidae/Mesoveliidae*	5	✓	✓		✓										✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Hydropsychidae 1sp	4																								✓
Ecmonidae	8				✓			✓													✓	✓			✓
Philopotamidae	10	✓				✓																			
Barbarochthonidae	13				✓	✓	✓								✓		✓						✓	✓	✓
Leptoceridae	6	✓	✓			✓										✓				✓	✓	✓	✓	✓	
Seicostomatidae																									✓
Dytiscidae*	5		✓	✓		✓									✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Ethmidae*	8																			✓	✓	✓	✓	✓	✓
Gyrinidae*	5																			✓	✓	✓	✓	✓	✓
Helodidae	12	✓	✓	✓		✓																			
Hydraenidae*	8				✓											✓							✓		
Hydrophilidae*	5	✓													✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Athericidae	10						✓	✓												✓	✓	✓			
Ceratopogonidae	5							✓																	
Chironomidae	2		✓	✓			✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Simuliidae	5				✓		✓								✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Cuticidae*	1															✓				✓			✓		

The following inferences can be drawn from the above results in Table 5:

HAV1 replacement:

- **Temporally at the upstream site**, both the SASS Total score (which is a measure of macro-invertebrate diversity) and ASPT score (which describes the average sensitivity of macro-invertebrates) insignificantly deteriorated and improved by 6.6% and 5.2%, respectively, for the current assessment compared to the initial January 2024 assessment (baseline). This decrease in both indices is most likely due to the significantly decreasing habitat suitability (IHAS score, by 20.0%). The decrease in habitat suitability is likely seasonally driven with lower base flows compared to the previous season.
- **Temporally at the downstream site**, both the SASS Total score (which is a measure of macro-invertebrate diversity) and ASPT score (which describes the average sensitivity of macro-invertebrates) significantly improved by 133.3% and 100%, respectively, for the current assessment compared to the initial January 2024 assessment (baseline). The presence of more taxa during the September 2025 assessment is a positive change.
- **Spatial comparisons** between the upstream and downstream sites, a downstream significant and insignificant deterioration in both SASS (21.1%) and ASPT (9.9%) scores was noted. The downstream deterioration could possibly be due to the significant increase in the Electrical Conductivity (EC).

T4/5:

- **Temporally at the upstream site**, the SASS Total score increased significantly by 100% and the ASPT score by 33.4% between the baseline and the current (September 2025) assessment. The IHAS score significantly increased by 18.6% when compared to the baseline assessment. When compared to the previous season the SASS score increased significantly by 276.0% whilst the ASPT score significantly increased by 50.4%. The habitat suitability (IHAS) score



increased by 15.9% when compared to the previous season (May 2025). The observed changes may be due to seasonal effects as well as the impact of fire on the system.

- **Temporally at the downstream site**, the SASS and ASPT total score significantly decreased by 53.5% with a slight increase in the ASPT score by 6.9% when compared to the January 2024 assessment. Habitat suitability (IHAS score) decreased by 15% when compared to the baseline and likely contributed to the observed decrease in SASS score as measure of diversity. When compared to the previous assessment the SASS score, and ASPT had decreased insignificantly by 13.1%, 4.5% and IHAS increased insignificantly 9.7%, respectively. The observed reductions indicate the same catchment wider drivers of change affecting this site.
- **Spatially between the upstream and downstream sites**, a downstream significant deterioration in both SASS5 (43.6%) and ASPT (15.5%) scores was noted despite a significant spatial increase in habitat suitability. The significant downstream deterioration in macro-invertebrate community diversity is likely due to the seasonal variation in macroinvertebrate assemblages.

As per Figure 7 below which has plotted the SASS Total score (x-axis) against the ASPT (y-axis) within the context of Present Ecological Status (PES). Thresholds “biological bands” for an upper longitudinal profile river in the Southern Folded Mountains Ecoregion, the following inferences can be drawn.

- The HAV1 Replacement upstream site remained unchanged from a PES Class A (Pristine) ecological condition between January 2024 and September 2025.
- The HAV1 Replacement downstream site’s ecological condition was a PES Class D (Largely Modified) ecological condition in January 2024 and improved to a Class B (Largely Natural) in the September 2025 assessment. This could be due to significant improvement of SASS5 and ASPT scores.
- The T4/5 upstream site improved from a PES Class E/F (Severely to Critically Modified) to a PES Class D (Largely Modified) ecological condition between January 2024 and September 2025 assessment, likely due to the significantly increasing SASS5 score and slightly increasing ASPT score; and
- The T4/5 downstream site deteriorated from a PES Class C (Moderately Modified) to a PES Class D (Largely Modified) ecological condition between January 2024 and September 2025 assessment, likely due to the significantly decreasing SASS5 score and ASPT score.

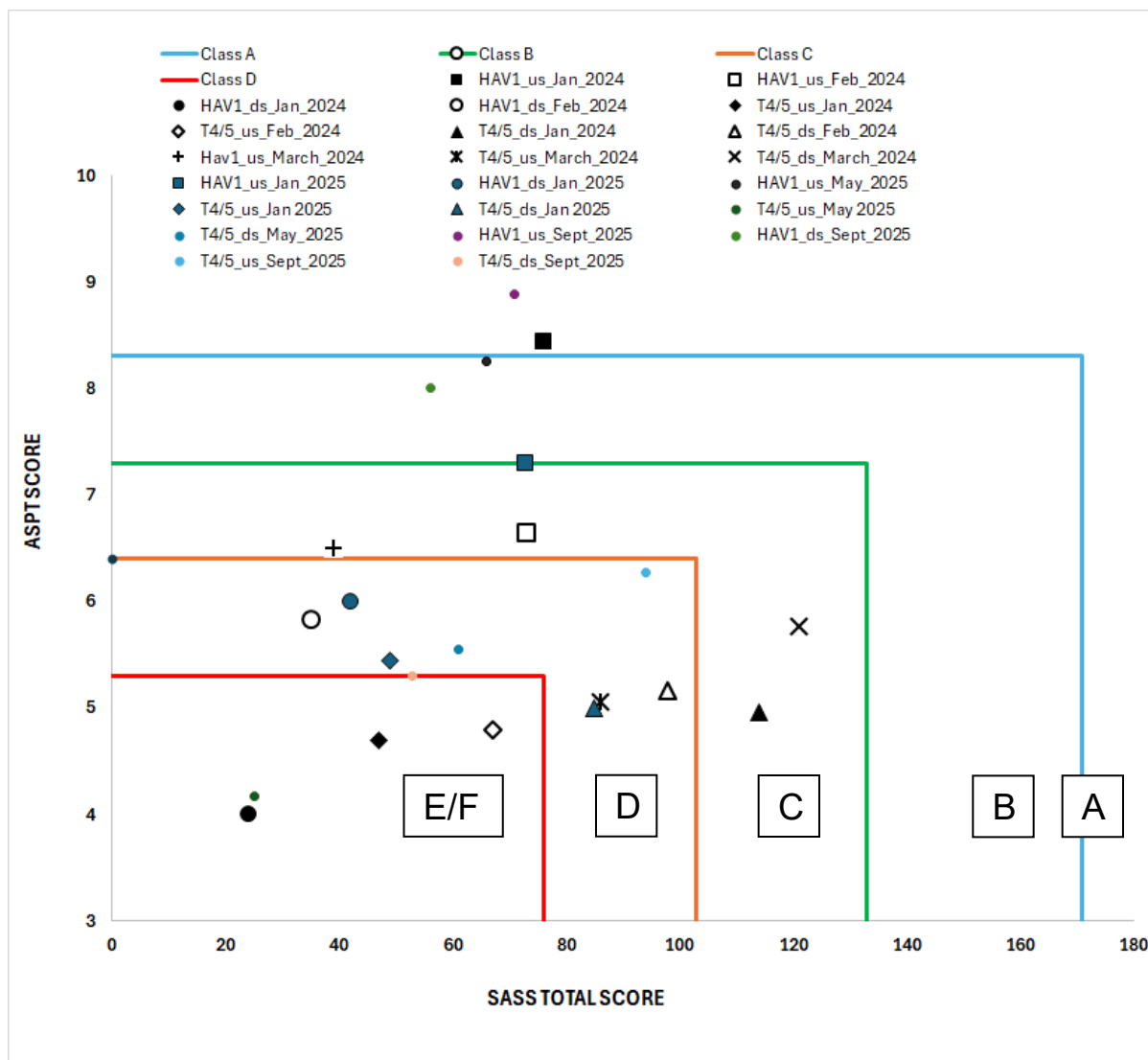
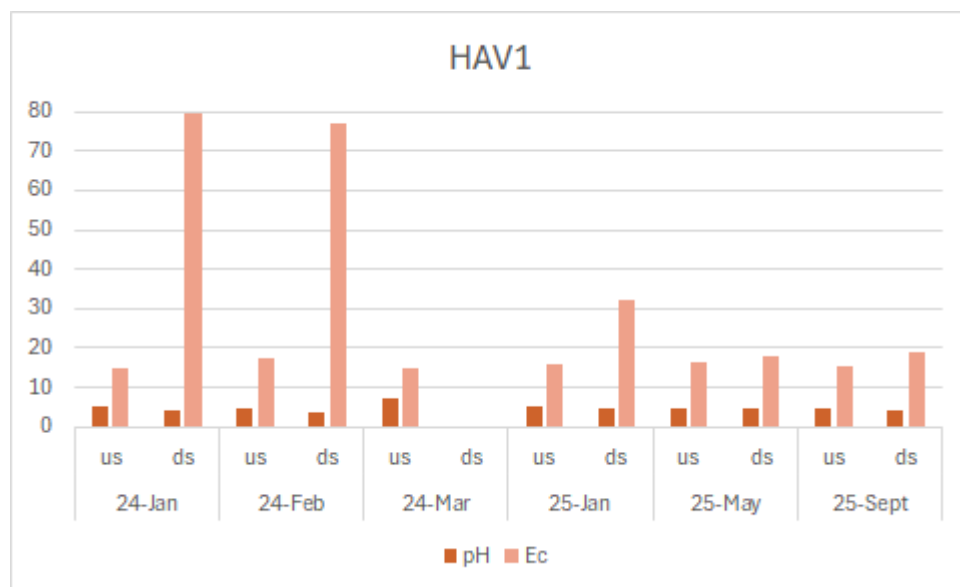


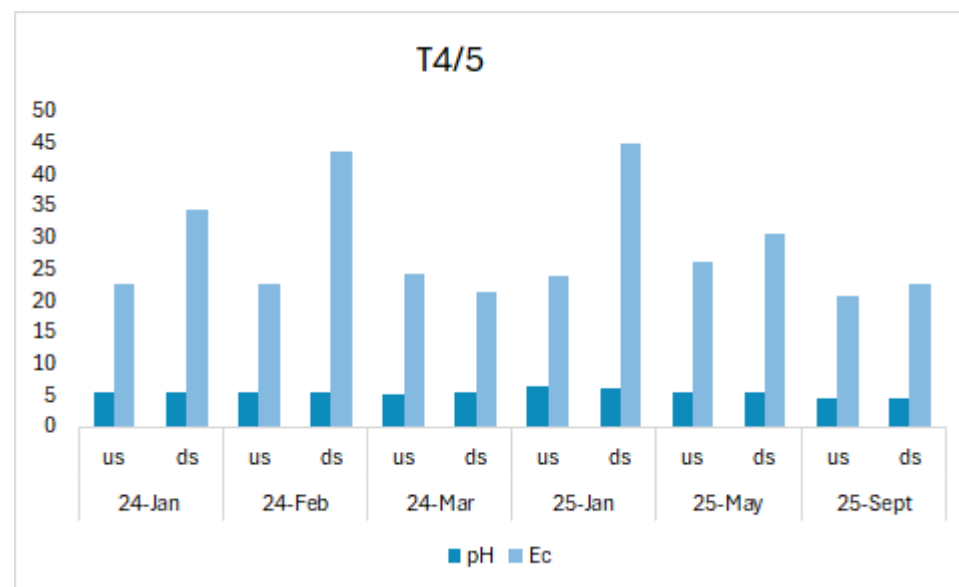
Figure 7: Scatterplots of the SASS total scores and ASPT scores within the context of their PES threshold scores as derived for an upper longitudinal profile river in the Southern Folded Mountains Ecoregion.

In Situ Physico-Chemistry

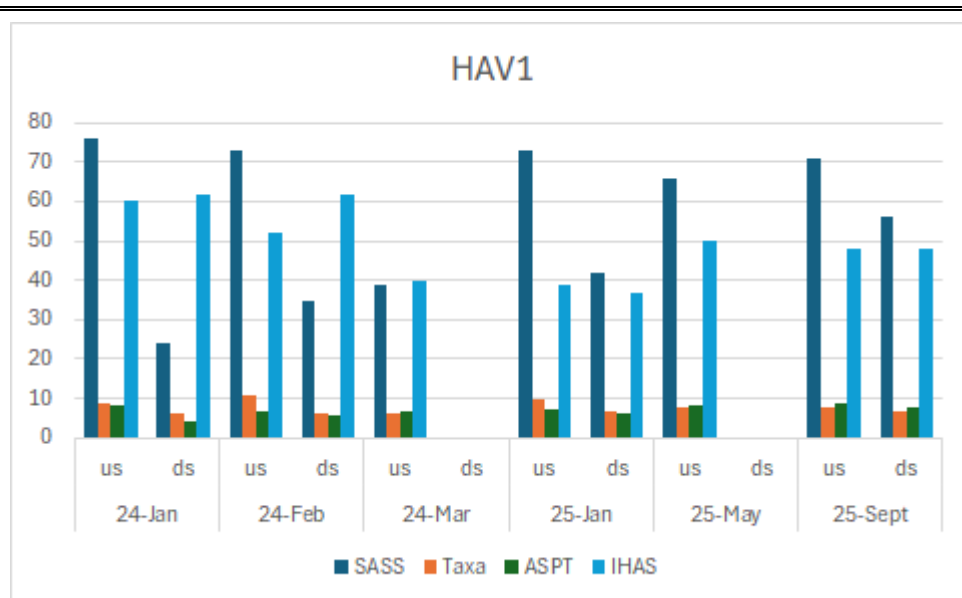
The measured pH and Electrical Conductivity (EC) for the HAV1 Replacement and T4/5 biomonitoring sites during the January, February, March 2024, January, May and September 2025 aquatic assessments are tabulated below in Table 4 and graphed below in Figure 8. The percentages in variation of the pH and EC at the HAV1 replacement and T4/5 biomonitoring sites were compared temporally and spatially in Table 6 below as well.

**Table 6: Spatial and temporal variations observed between site HAV1 and T4/5 in September 2025.****Figure 8: Spatial and temporal water quality variation between site HAV1_us and HAV1_ds****Comment:**

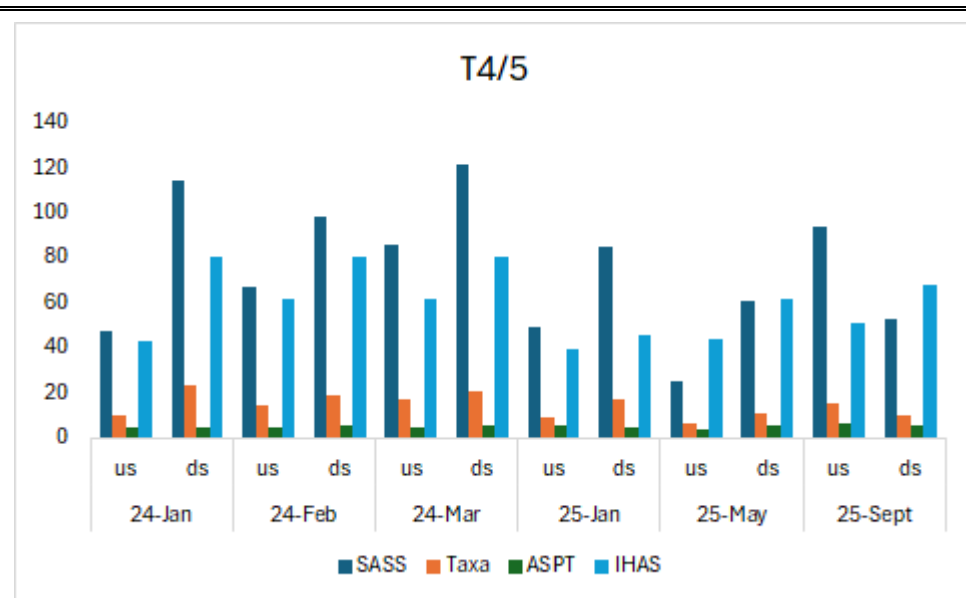
- Spatially, EC increased by 23.4% in a downstream direction and was considered a significant change, exceeding natural variability ranges. The increase is possibly due to cumulative impacts from catchment-wide anthropogenic sources. Seasonal changes such as low rainfall and increased evaporation, potentially contributed to the downstream increase in EC;
- EC had increased by 3.4% when compared to the baseline (January 2024). Figure 8 shows the trend in EC to increase in a downstream direction in the long term which possibly indicates catchment-wide activities which impact the river in a downstream direction;
- The pH was below natural levels at all sites and is slightly acidic, a negative impact from pH on sensitive taxa at the time of the September 2025 assessment is anticipated. The pH decreased in a downstream direction during the September 2025 assessment which implicates a potential source of acidic contamination between the sites (although local geology could also be a contributing factor);
- **In conclusion:** The September 2025 assessment results revealed a spatial deterioration in both the measured pH and EC in a downstream direction. As noted before, the majority of environmental deterioration is likely due to catchment-wide impacts compounded by seasonal natural flow constraints and local geology (for pH); and
- Ongoing monitoring at these points will need to continue to monitor existing trends and identify any emerging trends.

**Figure 9: Spatial and temporal water quality variation between site T4/5_us and T4/5_ds****Comment:**

- Spatially, EC increased by 8.1% in a downstream direction and was considered an insignificant and negative change. The increase is likely due to cumulative impacts from catchment-wide anthropogenic sources. Seasonal changes such as low rainfall and increased evaporation, potentially contributed to the downstream increase in EC;
- EC had decreased by 7.5% when compared to the baseline (January 2024). Figure 9 shows the trend in EC to increase in a downstream direction in the long term which possibly indicates sources of catchment-wide activities which impact the river in a downstream direction;
- The pH was considered slightly acidic and did not comply within natural levels at the upstream and downstream sites. This is seen as a negative impact at the time of the September 2025 assessment. Previous assessments show that pH remained largely stable;
- **In conclusion:** The September 2025 assessment results revealed a spatial deterioration in the measured EC in a downstream direction. As noted before, the majority of environmental deterioration is likely due to catchment-wide impacts compounded by seasonal natural flow constraints; and
- Ongoing monitoring at these points will need to continue to monitor existing trends and identify any emerging trends.

**Table 7: Spatial macro-invertebrate community integrity variation between site HAV1 and T4/5 in September 2025.****Figure 10: Spatial and temporal macro-invertebrate community integrity variation at HAV1****Comment:**

- Spatially, the macro-invertebrate community (SASS as measure of diversity) significantly decreased in a downstream direction and ASPT scores insignificantly decreased in a downstream direction. The Category deteriorated in a downstream direction from a Category A to a Category B.
- The macro-invertebrate habitat suitability was regarded as 'Poor' at the upstream and downstream site (HAV1 Replacement) according to the IHAS classification;
- Spatially, the macro-invertebrate community diversity (SASS5) and ASPT scores decreased in a downstream direction and the habitat suitability score remained unchanged;
- **In conclusion:** The improved community diversity and sensitivity at the downstream site can be ascribed to improved flow at this point. Some impacts on water quality at the downstream site may affect the aquatic community.
- It is deemed essential that the reason for the reduced flow between the two assessment points be determined

**Figure 11: Spatial and temporal macro-invertebrate community integrity variation at T4/5****Comment:**

- Spatially, the macro-invertebrate community integrity (SASS as measure of diversity) significantly decreased in a downstream direction but remained unchanged as a Category D (Largely Modified) condition at both sites T4/5_us and T4/5_ds.
- The macro-invertebrate habitat suitability was regarded as 'Poor' at the upstream site (T4/5_us) and Good at the downstream site (T4/5_ds) according to the IHAS classification;
- Spatially, the macro-invertebrate community diversity (SASS5) and ASPT scores decreased in a downstream direction by 43.6% and 15.5%, while the habitat suitability score increased by 33.3% respectively;
- **In conclusion:** the community diversity and sensitivity at the downstream site deteriorated. Some impacts on water quality at the downstream site may affect the aquatic community.



CONCLUSIONS

EC increased downstream by 8% – 24% at both downstream sites assessed, indicating a significant negative impact, likely due to dissolved ion accumulation and anthropogenic activities in the catchment. Seasonal influences (e.g. low rainfall, evaporation) contributed to the downstream EC increase. Compared to the January 2024 baseline assessment, EC decreased by 34% - 72%, however long-term increasing trends are still evident. pH was relatively low and was regarded as acidic, although this is natural in this environment. Overall, the September 2025 assessment showed deterioration, which is likely due to seasonal variation in flow and therefore largely natural. Habitat suitability was considered Poor from HAV_1 (upstream) and improved in a downstream direction from Poor to Good for T4/5. Macroinvertebrate community diversity (SASS5), ASPT and habitat suitability scores decreased at site T4/5 by 43.6%, 15.5%, and increased by 33.3%.

Given the very high erosive damage in the Hemel en Aarde catchment in general this is regarded as being outside of their normal biotic conditions, both from a habitat quality and water quality perspective. However, despite the above, concerns are raised with respect to significantly decreasing SASS5 and ASPT scores for the HAV1 Replacement upstream sites compared to the January 2024 assessment. The deterioration in macro-invertebrate community integrity is most likely due to significantly decreased habitat suitability and low flow. No points of concern are raised with respect to the macro-invertebrate community and the associated habitat during the post-construction phase of the pumphouse and pipelines for the T4/5 boreholes. The HAV1 “replacement” system may be affecting instream flow and this aspect should be investigated further.

RECOMMENDATIONS

- The potential erosion and siltation of streams must be continuously monitored in parallel with the SASS5 biomonitoring assessment, to ensure that the interstitial spaces of the streams, that are used as refugia for eggs and small/juvenile specimens, remain unclogged.
- Consideration should be given to instream flow monitoring of the systems with data monitored and assessed both spatially and temporally to determine if any impacts on the systems are occurring as a result of groundwater abstraction.
- In the event that the flows dry up to the degree that the SASS5 protocol can no longer be applied, the monitoring programme would need to be adjusted to accommodate the use of diatom and habitat indices that are appropriate under very low to zero flow environmental conditions.
- It is recommended that monitoring continues to identify long term trends by building a database and impacts on the Hemel en Aarde catchment.
- Land-use assessments are recommended to identify catchment-wide activities possibly contributing to the increased EC in a downstream direction.
- Promote the growth of riparian vegetation restoration to stabilize banks, reduce runoff and deposition into the river, and improve habitat conditions for macro-invertebrates.



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APPENDIX A – SASS5 Sheets

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET - MAY 2025

DATE: 03/09/2025	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	PORIFERA	5					HEMIPTERA:						DIPTERA:					
S: °	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E: °	TURBELLARIA	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: T4/5 Upstream	ANNELIDA:						Gerridae*	5					Ceratopogonidae	5				
RIVER:	Oligochaeta	1			A	A	Hydrometridae*	6					Chironomidae	2		B	A	B
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	CRUSTACEA:						Nepidae*	3					Dixidae*	10				
TEMP: 15,8 ° C	Amphipoda	13		B	A	B	Notonectidae*	3					Empididae	6				
Ph: 4,65	Potamonautidae*	3			1	1	Pleidae*	4					Ephydriidae	3				
DO: 16,7%	Atyidae	8					Veliidae/M...velidae*	5		A	A	A	Muscidae	1				
Cond: 20,9	Palaemonidae	10					MEGALOPTERA:						Psychodidae	1				
BIOTOPES SAMPLED:	HYDRACARINA	8					Cordalidae	8					Simuliidae	5		C	B	C
SIC: TIME: minutes	PLECOPTERA:						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14		A		A	TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1 sp	4			A	A	Hydropsychidae 1 sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6		B		B	Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocn.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13		1	A	A	Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					SASS SCORE:		0	81	61	94
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		0	11	10	15
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		####	7,36	6,10	6,27
	Chlorolestidae	8					Pisuliidae	10		B	A	B	IHAS:		%			
	Coenagrionidae	4		A		A	Sericostomatidae SWC	13					OTHER BIOTA:					
	Lestidae	8					COLEOPTERA:											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					COMMENTS:					
	Protonuridae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5		A		A	SWC = South Western Cape					
	Aeshnidae	8					Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8					S = Stone & rock					
	Libellulidae	4		A		A	Hydrophilidae*	5			1	1	VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					



RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET																		
DATE: 03/09/2025	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	PORIFERA	5					HEMIPTERA:						DIPTERA:					
S: °	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E: °	TURBELLARIA	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: T4/5 Downstream	ANNELIDA:						Gerridae*	5					Ceratopogonidae	5				
RIVER:	Oligochaeta	1			1		Hydrometridae*	6		1		1	Chironomidae	2	B	A	B	B
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	CRUSTACEA:						Nepidae*	3					Dixidae*	10				
TEMP: 16,9 ° C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 4,43	Potamonautidae*	3					Pleidae*	4					Ephydriidae	3				
DO: 15,9%	Atyidae	8					Veliidae/M...velliidae*	5		1	B	B	Muscidae	1				
Cond: 22,6	Palaemonidae	10					MEGALOPTERA:						Psychodidae	1				
BIOTOPES SAMPLED:	HYDRACARINA	8					Cordalidae	8					Simuliidae	5	B	B	B	C
SIC: TIME: minutes	PLECOPTERA:						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1 sp	4	A		A	B	Hydropsychidae 1 sp	4	1			1	Ancyliidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6		A		A	Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeraeidae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocn.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
DISTURBANCE IN RIVER:	ODONATA:						Lepidostomatidae	10					SASS SCORE:		28	45	17	53
	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		5	8	5	10
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		5,60	5,63	3,40	5,30
	Chlorolestidae	8					Pisuliidae	10					IHAS:		%			
	Coenagrionidae	4		1		1	Sericostomatidae SWC	13	A	A		A	OTHER BIOTA:					
	Lestidae	8					COLEOPTERA:						COMMENTS:					
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					* = airbreathers					
	Protoneuridae	8					Elmidae/Dryopidae*	8					SWC = South Western Cape					
	Zygoptera juvs.	6					Gyrinidae*	5					T = Tropical					
	Aeshnidae	8					Halipidae*	5					ST = Sub-tropical					
	Corduliidae	8					Helodidae	12					S = Stone & rock					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8					VG = all vegetation					
	Libellulidae	4		1		1	Hydrophilidae*	5					GSM = gravel, sand & mud					
	LEPIDOPTERA:						Limnichidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					
	Pyralidae	12					Psephenidae	10										



RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET																		
DATE: 03/09/2025	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	PORIFERA	5					HEMIPTERA:						DIPTERA:					
S: °	COELENTERATA	1					Belostomatidae*	3					Athericidae	10			A	A
E: °	TURBELLARIA	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: HAV1/US	ANNELIDA:						Gerridae*	5					Ceratopogonidae	5				
RIVER:	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2			A	A
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	CRUSTACEA:						Nepidae*	3					Dixidae*	10				
TEMP: 18,2 ° C	Amphipoda	13			A	A	Notonectidae*	3					Empididae	6				
Ph: 4,54	Potamonautidae*	3					Pleidae*	4					Ephydriidae	3				
DO: 16,4%	Atyidae	8					Veliidae/M...veliidae*	5					Muscidae	1				
Cond: 15.4	Palaemonidae	10					MEGALOPTERA:						Psychodidae	1				
BIOTOPES SAMPLED:	HYDRACARINA	8					Cordalidae	8					Simuliidae	5			B	B
SIC: TIME: minutes	PLECOPTERA:						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14			B	B	TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1 sp	4					Hydropsychidae 1 sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6			B	B	Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13			1	1	Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					SASS SCORE:		0	0	71	71
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		0	0	8	8
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		####	####	8,88	8,88
	Chlorolestidae	8					Pisuliidae	10					IHAS:		%			
	Coenagrionidae	4					Sericostomatidae SWC	13					OTHER BIOTA:					
	Lestidae	8					COLEOPTERA:											
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					COMMENTS:					
	Protoneuridae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5					SWC = South Western Cape					
	Aeshnidae	8					Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8			1	1	S = Stone & rock					
	Libellulidae	4					Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA:						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					



RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET																		
DATE: 03/09/2025	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	PORIFERA	5					HEMIPTERA:						DIPTERA:					
S: °	COELENTERATA	1					Belostomatidae*	3					Athericidae	10			1	1
E: °	TURBELLARIA	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: HAV1 Downstream	ANNELIDA:						Gerridae*	5					Ceratopogonidae	5				
RIVER:	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2				
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	CRUSTACEA:						Nepidae*	3					Dixidae*	10				
TEMP: 18,2° C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 4,33	Potamonautidae*	3					Pleidae*	4					Ephydriidae	3				
DO: 17,5%	Atyidae	8					Veliidae/M...velliidae*	5			1	1	Muscidae	1				
Cond: 19,0	Palaemonidae	10					MEGALOPTERA:						Psychodidae	1				
BIOTOPES SAMPLED:	HYDRACARINA	8					Cordalidae	8					Simuliidae	5			A	A
SIC: TIME: minutes	PLECOPTERA:						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14			1	1	TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1 sp	4			A	A	Hydropsychidae 1 sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeraeidae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocn.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13			A	A	Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					SASS SCORE:		0	0	56	56
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		0	0	7	7
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		####	####	8,00	8,00
	Chlorolestidae	8					Pisuliidae	10					IHAS:		%			
	Coenagrionidae	4					Sericostomatidae SWC	13					OTHER BIOTA:					
	Lestidae	8					COLEOPTERA:						COMMENTS:					
SIGNS OF POLLUTION:	Platycnemidae	10					Dytiscidae*	5					* = airbreathers					
	Protoneuridae	8					Elmidae/Dryopidae*	8					SWC = South Western Cape					
	Zygoptera juvs.	6					Gyrinidae*	5					T = Tropical					
	Aeshnidae	8					Halipidae*	5					ST = Sub-tropical					
	Corduliidae	8					Helodidae	12					S = Stone & rock					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8					VG = all vegetation					
	Libellulidae	4					Hydrophilidae*	5			1	1	GSM = gravel, sand & mud					
	LEPIDOPTERA:						Limnichidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					
	Pyralidae	12					Psephenidae	10										



APPENDIX B – IHAS Sheets

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name: Perennial stream of the Onrus River						
Site Name: T4/5 upstream	Date: 03 September 2025					
SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min) (* NOTE: up to 25% of stone is usually embedded in the stream bottom)	0	<1	>1-2	2	>2-3	>3
SIC Score (max 20):						0
VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none		1-25	26-50	51-75	>75
Vegetation Score (max 15):						9
OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time) (** NOTE: you must still fill in the SIC section)		under		corr		over
Other Habitat Score (max 20):						10
HABITAT TOTAL (MAX 55):						19
STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>1	1	>½-1	½	<½-¼	<¼
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	50-80	81-95	>95		
(** NOTE: if more than one option, choose the lowest)						
STREAM CONDITIONS TOTAL (MAX 45):						32
TOTAL IHAS SCORE (%):						51



INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name: Perennial stream of the Onrus River						
Site Name: T4/5 Downstream	Date: 03 September 2025					
SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min) (* NOTE: up to 25% of stone is usually embedded in the stream bottom)	0	<1	>1-2	2	>2-3	>3
SIC Score (max 20):			15			
VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none		1-25	26-50	51-75	>75
Vegetation Score (max 15):			9			
OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time) (** NOTE: you must still fill in the SIC section)		under		corr		over
Other Habitat Score (max 20):			13			
HABITAT TOTAL (MAX 55):			37			
STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>1	1	>½-1	½	<½-¼	<¼
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	50-80	81-95	>95		
STREAM CONDITIONS TOTAL (MAX 45):			31			
TOTAL IHAS SCORE (%):			68			



INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name: Seasonal Stream of the Onrus River						
Site Name: HAV1 Replacement Upstream	Date: 03 September 2025					
SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min) (* NOTE: up to 25% of stone is usually embedded in the stream bottom)	0	<1	>1-2	2	>2-3	>3
SIC Score (max 20):						0
VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none		1-25	26-50	51-75	>75
Vegetation Score (max 15):						5
OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
Other Habitat Score (max 20):						13
HABITAT TOTAL (MAX 55):						18
STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>1	1	>½-1	½	<½-¼	<¼
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	50-80	81-95	>95		
STREAM CONDITIONS TOTAL (MAX 45):						31
TOTAL IHAS SCORE (%):						49



INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name: Seasonal Stream of the Onrus River						
Site Name: HAV1 repl downstream	Date: 03 September 2025					
SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min) (* NOTE: up to 25% of stone is usually embedded in the stream bottom)	0	<1	>1-2	2	>2-3	>3
	SIC Score (max 20):					0
VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none		1-25	26-50	51-75	>75
	Vegetation Score (max 15):					8
OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'corr' = correct time) (** NOTE: you must still fill in the SIC section)		under		corr		over
	Other Habitat Score (max 20):					11
	HABITAT TOTAL (MAX 55):					19
STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>1	1	>½-1	½	<½-¼	<¼
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	50-80	81-95	>95		
(*** NOTE: if more than one option, choose the lowest)						
	STREAM CONDITIONS TOTAL (MAX 45):					29
	TOTAL IHAS SCORE (%):					48

APPENDIX C – SASS and IHAS Field Sheets

HAV1 REPL-T4/5 BOREHOLES S21(C)-(I) MONITORING REPORT JAN-SEP 2025

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET																		
DATE : 03/04/2025	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE :	PORIFERA	5					HEMIPTERA :						DIPTERA :					
S:°	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E:°	TURBELLARIA	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: HAV1US	ANNELIDA :						Gerridae*	5					Ceratopogonidae	5				
RIVER:	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2		A	A	
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	CRUSTACEA :						Nepidae*	3					Dixidae*	10				
TEMP: 19.4 °C	Amphipoda	13			B	B	Notonectidae*	3					Empididae	6				
Ph: 3.69	Potamonautidae*	3			A	A	Pleidae*	4					Ephyridae	3				
DO: mg/l	Atyidae	8					Veliidae/M...veliidae*	5			A	A	Muscidae	1				
Cond: 16.0 mS/m	Palaemonidae	10					MEGALOPTERA :						Psychodidae	1				
BIOTOPES SAMPLED :	HYDRACARINA	8					Cordulidae	8					Simuliidae	5				
SIC: TIME: minutes	PLECOPTERA :						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8			A	A	GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1sp	4			1	1	Hydropsychidae 1sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW :	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY :	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosoptomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Tetragonidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydropsalpingidae SWC	15					Unionidae	6				
	ODONATA :						Lepidostomatidae	10					SASS SCORE:		0	0	59	59
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		0	0	9	9
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		0.00	0.00	6.56	6.56
	Chlorolestidae	8					Pisuliidae	10					IHAS :		34%			
	Coenagrionidae	4			1	1	Sericostomatidae SWC	13					OTHER BIOTA :					
	Lestidae	8					COLEOPTERA :											
SIGNS OF POLLUTION:	Platynemidae	10					Dytiscidae*	5					COMMENTS :					
	Protonemidae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5					SWC = South Western Cape					
	Aeshnidae	8					Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12			A	A	ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8			1	1	S = Stone & rock					
Low flow. Some litter present. A lot of alien invasive species in surrounding area.	Libellulidae	4					Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA :						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

Appendix C-ii

HAV1 REPL-T4/5 BOREHOLES S21(C)-(I) MONITORING REPORT JAN-SEP 2025

DATE : 03/04/2025	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE :	PORIFERA	5					HEMIPTERA:						DIPTERA:					
S:°	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E:°	TURBELLARIA	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: HAV1Downstream	ANNELIDA:						Gerridae*	5					Ceratopogonidae	5				
RIVER:	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2				
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	CRUSTACEA:						Nepidae*	3					Dixidae*	10				
TEMP:	Amphipoda	13					Notoineptidae*	3					Empididae	6				
Ph:	Potamonautidae*	3					Pleidae*	4					Ephydriidae	3				
DO: mg/l	Atyidae	8					Veliidae/M...velidae*	5					Muscidae	1				
Cond:	Palaemonidae	10					MEGALOPTERA:						Psychodidae	1				
BIOTOPES SAMPLED:	HYDRACARINA	8					Cordulidae	8					Simuliidae	5				
SIC: TIME: minutes	PLECOPTERA:						Sialidae	6					Syrphidae*	1				
SOOC:	Notoemuridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocent.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					SASS SCORE:		0	0	0	0
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		0	0	0	0
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		0.00	0.00	###	###
	Chlorolestidae	8					Pisuliidae	10					IHAS:					
	Coenagrionidae	4					Sericostomatidae SWC	13					OTHER BIOTA:					
	Lestidae	8					COLEOPTERA:						COMMENTS:					
SIGNS OF POLLUTION:	Platynemidae	10					Dytiscidae*	5					* = airbreathers					
	Protonemidae	8					Elmidae/Dryopidae*	8					SWC = South Western Cape					
	Zygoptera juvs.	6					Gyrinidae*	5					T = Tropical					
	Aeshnidae	8					Halipidae*	5					ST = Sub-tropical					
	Corduliidae	8					Helodidae	12					S = Stone & rock					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8					VG = all vegetation					
Site was dry.	Libellulidae	4					Hydrophilidae*	5					GSM = gravel, sand & mud					
	LEPIDOPTERA:						Limnichidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					
	Pyralidae	12					Psephenidae	10										

Appendix C-iii

HAV1 REPL-T4/5 BOREHOLES S21(C)-(I) MONITORING REPORT JAN-SEP 2025

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET																		
DATE : 03/04/2025	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE : S:° E:°	PORIFERA	5					HEMIPTERA :						DIPTERA :					
	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
	TURBELLARIA	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: T4/5 upstream	ANNELIDA :						Gerridae*	5					Ceratopogonidae	5				
RIVER:	Oligochaeta	1			1	1	Hydrometridae*	6					Chironomidae	2			1	1
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	CRUSTACEA :						Nepidae*	3			A	A	Dixidae*	10				
TEMP: 17.9 °C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 5.05	Potamonautidae*	3			1	1	Pleidae*	4					Ephyrididae	3				
DO: mg/l	Atyidae	8					Veliidae/M...veliidae*	5			A	A	Muscidae	1				
Cond: 28.0 mS/m	Palaemonidae	10					MEGALOPTERA :						Psychodidae	1				
BIOTOPES SAMPLED :	HYDRACARINA	8					Cordalidae	8					Simuliidae	5				
SIC: TIME: minutes	PLECOPTERA :						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychoomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW: Low flow.	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY :	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydropsalpingidae SWC	15					Unionidae	6				
	ODONATA :						Lepidostomatidae	10					SASS SCORE:		0	0	46	46
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		0	0	11	11
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		0.00	0.00	4.18	4.18
	Chlorolestidae	8					Pisuliidae	10					IHAS:		34%			
	Coenagrionidae	4			A	A	Sericostomatidae SWC	13					OTHER BIOTA :					
	Lestidae	8					COLEOPTERA :											
SIGNS OF POLLUTION:	Platynemidae	10					Dytiscidae*	5			1	1	COMMENTS :					
	Protoneuridae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5			A	A	SWC = South Western Cape					
	Aeshnidae	8			1	1	Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6			1	1	Hydraenidae*	8					S = Stone & rock					
	Libellulidae	4			1	1	Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA :						Limnichidae	10					GSM = gravel, sand & mud					
	Pyralidae	12					Psephenidae	10					1=1,A=2-10,B=10-100,C=100-1000,D=>1000					

Appendix C-iv

HAV1 REPL-T4/5 BOREHOLES S21(C)-(I) MONITORING REPORT JAN-SEP 2025

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET																		
DATE : 03/04/25	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE :	PORIFERA	5					HEMIPTERA :						DIPTERA :					
S:°	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E:°	TURBELLARIA	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: T4/5 downstream	ANNELIDA :						Gerridae*	5					Ceratopogonidae	5				
RIVER:	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2		1	A	A
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1			A	A
WEATHER CONDITION:	CRUSTACEA :						Nepidae*	3		1		1	Dixidae*	10				
TEMP: 19.1°C	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 4.93	Potamonautidae*	3		1	1	A	Pleidae*	4					Ephyridae	3				
DO: mg/l	Atyidae	8					Veliidae/M...velidae*	5		A	1	A	Muscidae	1				
Cond: 410 mS/m	Palaemonidae	10					MEGALOPTERA :						Psychodidae	1				
BIOTOPES SAMPLED :	HYDRACARINA	8					Cordalidae	8					Simuliidae	5		A	A	B
SIC: TIME: minutes	PLECOPTERA :						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4			A	A	Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW :	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY :	Oligoneuridae	15					Barbarochthonidae SWC	13			B	B	Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA :						Lepidostomatidae	10					SASS SCORE:		0	37	67	79
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6			A	A	NO OF TAXA:		0	9	13	16
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		0.00	4.11	5.15	4.94
	Chlorolestidae	8					Pisuliidae	10					IHAS :		50%			
	Coenagrionidae	4		A		A	Sericostomatidae SWC	13					OTHER BIOTA :					
	Lestidae	8					COLEOPTERA :											
SIGNS OF POLLUTION:	Platynemidae	10					Dytiscidae*	5			A	A	COMMENTS :					
	Protonemuridae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5			A	A	SWC = South Western Cape					
	Aeshnidae	8					Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6		A	B	B	Hydraenidae*	8			1	1	S = Stone & rock					
Fish present ; low flow	Libellulidae	4		1	A	A	Hydrophilidae*	5		1		1	VG = all vegetation					
	LEPIDOPTERA :						Limnichidae	10					GSM = gravel, sand & mud					
	Pvralidae	12					Psephenidae	10					1=1 A=2-10, B=10-100, C=100-1000, D=>1000					

Appendix C-v

HAV1 REPL-T4/5 BOREHOLES S21(C)-(I) MONITORING REPORT JAN-SEP 2025

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET																		
DATE : 05/05/2025	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE :	PORIFERA	5					HEMIPTERA :						DIPTERA :					
S:°	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E:°	TURBELLARIA	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: HAV1Upstream	ANNELIDA :						Gerridae*	5					Ceratopogonidae	5				
RIVER:	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2				
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	CRUSTACEA :						Nepidae*	3					Dixidae*	10				
TEMP: 14.6 °C	Amphipoda	13			B	B	Notonectidae*	3					Empididae	6				
Ph: 4.94	Potamonautidae*	3			A	A	Pleidae*	4					Ephyridae	3				
DO: mg/l	Atyidae	8					Veliidae/M...veliidae*	5			A	A	Muscidae	1				
Cond: 14.6mS/m	Palaemonidae	10					MEGALOPTERA :						Psychodidae	1				
BIOTOPES SAMPLED :	HYDRACARINA	8					Cordalidae	8					Simuliidae	5			A	A
SIC: TIME: minutes	PLECOPTERA :						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8			A	A	GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4			A	A	Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6			1	1	Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW: Higher flows observed than previous sampling periods.	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY :	Oligoneuridae	15					Barbarochthonidae SWC	13			1	1	Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA :						Lepidostomatidae	10					SASS SCORE:		0	0	70	70
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		0	0	10	10
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT :		0.00	0.00	7.00	7.00
	Chlorolestidae	8					Pisuliidae	10					IHAS :		39%			
	Coenagrionidae	4					Sericostomatidae SWC	13					OTHER BIOTA :					
	Lestidae	8					COLEOPTERA :											
SIGNS OF POLLUTION:	Platynemidae	10					Dytiscidae*	5			1	1	COMMENTS :					
	Protoneuridae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5					SWC = South Western Cape					
	Aeshnidae	8					Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8			1	1	S = Stone & rock					
	Libellulidae	4					Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA :						Limnichidae	10					GSM = gravel, sand & mud					
	Psephidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

Appendix C-vi

HAV1 REPL-T4/5 BOREHOLES S21(C)-(I) MONITORING REPORT JAN-SEP 2025

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET																		
DATE : 05/05/2025	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE :	PORIFERA	5					HEMIPTERA :						DIPTERA :					
S:°	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E:°	TURBELLARIA	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: HAV1Downstream	ANNELIDA :						Gerridae*	5					Ceratopogonidae	5				
RIVER:	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2				
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	CRUSTACEA :						Nepidae*	3					Dixidae*	10				
TEMP:	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph:	Potamonautidae*	3					Pleidae*	4					Ephyridae	3				
DO: mg/l	Atyidae	8					Veliidae/M...veliidae*	5					Muscidae	1				
Cond:	Palaemonidae	10					MEGALOPTERA :						Psychodidae	1				
BIOTOPES SAMPLED :	HYDRACARINA	8					Cordalidae	8					Simuliidae	5				
SIC: TIME: minutes	PLECOPTERA :						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psycho myiidae/Xiphocen.	8					Planorbidae*	3				
FLOW :	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY :	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA :						Lepidostomatidae	10					SASS SCORE:		0	0	0	0
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		0	0	0	0
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		0.00	0.00	###	###
	Chlorolestidae	8					Pisuliidae	10					IHAS :		37%			
	Coenagrionidae	4					Sericostomatidae SWC	13					OTHER BIOTA :					
	Lestidae	8					COLEOPTERA :											
SIGNS OF POLLUTION:	Platynemidae	10					Dytiscidae*	5					COMMENTS :					
	Protonemidae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5					SWC = South Western Cape					
	Aeshnidae	8					Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8					S = Stone & rock					
Site dry.	Libellulidae	4					Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA :						Limnichidae	10					GSM = gravel, sand & mud					
	Pvralidae	12					Psephenidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					

HAV1 REPL-T4/5 BOREHOLES S21(C)-(I) MONITORING REPORT JAN-SEP 2025

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET																		
DATE : 05/05/25	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE : S:° E:°	PORIFERA	5					HEMIPTERA :						DIPTERA :					
	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
	TURBELLARIA	3					Corixidae*	3			A	A	Blepharoceridae	15				
SITE CODE: T4/5 upstream	ANNELIDA :						Gerridae*	5			1	1	Ceratopogonidae	5				
RIVER:	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2			1	1
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1			1	1
WEATHER CONDITION:	CRUSTACEA :						Nepidae*	3					Dixidae*	10				
TEMP: 16.3 °C	Amphipoda	13			A	A	Notonectidae*	3					Empididae	6				
Ph: 5.14	Potamonautidae*	3			1	1	Pleidae*	4					Ephyridae	3				
DO: mg/l	Atyidae	8					Veliidae/M...veliidae*	5			A	A	Muscidae	1				
Cond: 33 mS/m	Palaemonidae	10					MEGALOPTERA :						Psychodidae	1				
BIOTOPES SAMPLED :	HYDRACARINA	8					Cordalidae	8					Simuliidae	5			A	A
SIC: TIME: minutes	PLECOPTERA :						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1sp	4			1	1	Hydropsychidae 1sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psycho myiidae/Xiphocen.	8					Planorbidae*	3				
FLOW :	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY :	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA :						Lepidostomatidae	10					SASS SCORE:		0	0	67	67
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA :		0	0	14	14
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		0.00	0.00	4.79	4.79
	Chlorolestidae	8					Pisuliidae	10					IHAS :		39%			
	Coenagrionidae	4			A	A	Sericostomatidae SWC	13					OTHER BIOTA :					
	Lestidae	8					COLEOPTERA :											
SIGNS OF POLLUTION:	Platynemidae	10					Dytiscidae*	5			1	1	COMMENTS :					
	Protonemidae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5					SWC = South Western Cape					
	Aeshnidae	8			A	A	Halipidae*	5					T = Tropical					
	Corduliidae	8					Helo didae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8					S = Stone & rock					
	Libellulidae	4			A	A	Hydrophilidae*	5			1	1	VG = all vegetation					
	LEPIDOPTERA :						Limnichidae	10					GSM = gravel, sand & mud					
	Pvralidae	12					Psephenidae	10					1=1 A=2-10, B=10-100, C=100-1000, D=>1000					

Appendix C-viii

HAV1 REPL-T4/5 BOREHOLES S21(C)-(I) MONITORING REPORT JAN-SEP 2025

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET																		
DATE : 05/05/25	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE : S:° E:°	PORIFERA	5					HEMIPTERA :						DIPTERA :					
	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
	TURBELLARIA	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: T4/5 downstream	ANNELIDA :						Gerridae*	5					Ceratopogonidae	5				
RIVER:	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2	A	A	A	
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	CRUSTACEA :						Nepidae*	3					Dixidae*	10				
TEMP: 15.4 °C	Amphipoda	13		1	1	A	Notonectidae*	3					Empididae	6				
Ph: 5.33	Potamonautidae*	3			1	1	Pleidae*	4					Ephydriidae	3				
DO: mg/l	Atyidae	8					Veliidae/M...veliidae*	5		A	B	B	Muscidae	1				
Cond: 52.0 mS/m	Palaemonidae	10					MEGALOPTERA :						Psychodidae	1				
BIOTOPES SAMPLED :	HYDRACARINA	8					Cordalidae	8					Simuliidae	5			A	A
SIC: TIME: minutes	PLECOPTERA :						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW :	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY :	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydropsalpingidae SWC	15					Unionidae	6				
	ODONATA :						Lepidostomatidae	10					SASS SCORE:		0	47	53	71
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6			A	A	NO OF TAXA:		0	8	10	13
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		0.00	5.88	5.30	5.46
	Chlorolestidae	8					Pisuliidae	10					IHAS :		46%			
	Coenagrionidae	4				A	A	Sericostomatidae SWC	13				OTHER BIOTA :					
	Lestidae	8					COLEOPTERA :						COMMENTS :					
SIGNS OF POLLUTION:	Platynemidae	10					Dytiscidae*	5		A		A	* = airbreathers					
	Protonemuridae	8					Elmidae/Dryopidae*	8		A		A	SWC = South Western Cape					
	Zygoptera juvs.	6					Gyrinidae*	5		A	A	A	T = Tropical					
	Aeshnidae	8					Halipidae*	5					ST = Sub-tropical					
	Corduliidae	8					Helodidae	12					S = Stone & rock					
OTHER OBSERVATIONS:	Gomphidae	6				B	B	Hydraenidae*	8				VG = all vegetation					
	Libellulidae	4		1		A	A	Hydrophilidae*	5		A		A	GSM = gravel, sand & mud				
	LEPIDOPTERA :							Limnichidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000				
	Pyrvalidae	12						Psephenidae	10									

Appendix C-ix

HAV1 REPL-T4/5 BOREHOLES S21(C)-(I) MONITORING REPORT JAN-SEP 2025

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET																		
DATE : 30/06/2025	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE :	PORIFERA	5					HEMIPTERA :						DIPTERA :					
S:°	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E:°	TURBELLARIA	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: HAV1Upstream	ANNELIDA :						Gerridae*	5					Ceratopogonidae	5				
RIVER:	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2				
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	CRUSTACEA :						Nepidae*	3					Dixidae*	10				
TEMP: 13.1°C	Amphipoda	13	B	B	B	B	Notonectidae*	3					Empididae	6				
Ph: 4.38	Potamonautidae*	3			1	1	Pleidae*	4					Ephyridae	3				
DO: mg/l	Atyidae	8					Veliidae/M...veliidae*	5					Muscidae	1				
Cond: 27.0mS/m	Palaemonidae	10					MEGALOPTERA :						Psychodidae	1				
BIOTOPES SAMPLED :	HYDRACARINA	8					Cordalidae	8					Simuliidae	5	A	B	1	B
SIC: TIME: minutes	PLECOPTERA :						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14	A			A	TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1sp	4		A		A	Hydropsychidae 1sp	4	A			A	Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6	A	B	A	B	Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeraidae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW: High, fast	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY: Clear water	Oligoneuridae	15					Barbarochthonidae SWC	13		A		A	Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydropsalpingidae SWC	15					Unionidae	6				
	ODONATA :						Lepidostomatidae	10		1		1	SASS SCORE:		42	59	27	80
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		5	7	4	10
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		0.00	0.00	6.75	8.00
	Chlorolestidae	8					Pisuliidae	10					IHAS:		39%			
	Coenagrionidae	4					Sericostomatidae SWC	13					OTHER BIOTA :					
	Lestidae	8					COLEOPTERA :						COMMENTS :					
SIGNS OF POLLUTION:	Platynemidae	10					Dytiscidae*	5					* = airbreathers					
	Protonemuridae	8					Elmidae/Dryopidae*	8		A		A	SWC = South Western Cape					
	Zygoptera juvs.	6					Gyrinidae*	5					T = Tropical					
	Aeshnidae	8					Halipidae*	5					ST = Sub-tropical					
	Corduliidae	8					Helodidae	12					S = Stone & rock					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8					VG = all vegetation					
	Libellulidae	4					Hydrophilidae*	5					GSM = gravel, sand & mud					
	LEPIDOPTERA :						Limnichidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					
	Pvralidae	12					Psephenidae	10										

Appendix C-x

HAV1 REPL-T4/5 BOREHOLES S21(C)-(I) MONITORING REPORT JAN-SEP 2025

DATE: 30/06/2025	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	PORIFERA	5					HEMIPTERA:						DIPTERA:					
S:°	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E:°	TURBELLARIA	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: HAV1Downstream	ANNELIDA:						Gerridae*	5					Ceratopogonidae	5				
RIVER:	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2		1	1	
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	CRUSTACEA:						Nepidae*	3					Dixidae*	10				
TEMP: 13.7	Amphipoda	13					Notonectidae*	3					Empididae	6				
Ph: 4.11	Potamonautidae*	3					Pleidae*	4					Ephyridae	3				
DO: mg/l	Atyidae	8					Veliidae/M. veliidae*	5					Muscidae	1				
Cond: 28.0mS/m	Palaemonidae	10					MEGALOPTERA:						Psychodidae	1				
BIOTOPES SAMPLED:	HYDRACARINA	8					Cordalidae	8					Simuliidae	5				
SIC: TIME: minutes	PLECOPTERA:						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1sp	4					Hydropsychidae 1sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphoc. cen.	8					Planorbidae*	3				
FLOW:	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY:	Oligoneuridae	15			1	1	Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					SASS SCORE:		0	5	17	22
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		0	1	2	3
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		0.00	0.00	8.50	7.33
	Chlorolestidae	8					Pisuliidae	10					IHAS:		37%			
	Coenagrionidae	4					Sericostomatidae SWC	13					OTHER BIOTA:					
	Lestidae	8					COLEOPTERA:						COMMENTS:					
SIGNS OF POLLUTION:	Platynemidae	10					Dytiscidae*	5		1		1	* = airbreathers					
	Protonuridae	8					Elmidae/Dryopidae*	8					SWC = South Western Cape					
	Zygoptera juvs.	6					Gyrinidae*	5					T = Tropical					
	Aeshnidae	8					Halipidae*	5					ST = Sub-tropical					
	Corduliidae	8					Helodidae	12					S = Stone & rock					
OTHER OBSERVATIONS:	Gomphidae	6					Hydraenidae*	8					VG = all vegetation					
Site dry.	Libellulidae	4					Hydrophilidae*	5					GSM = gravel, sand & mud					
	LEPIDOPTERA:						Limnichidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					
	Pyralidae	12					Psephenidae	10										

Appendix C-xi

HAV1 REPL-T4/5 BOREHOLES S21(C)-(I) MONITORING REPORT JAN-SEP 2025

RIVER HEALTH PROGRAMME - SASS 5 SCORE SHEET																		
DATE : 30/06/25	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE :	PORIFERA	5					HEMIPTERA :						DIPTERA :					
S:°	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E:°	TURBELLARIA	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: T4/5 upstream	ANNELIDA :						Gerridae*	5					Ceratopogonidae	5				
RIVER:	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2			A	A
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	CRUSTACEA :						Nepidae*	3		A		A	Dixidae*	10				
TEMP: 26.6 °C	Amphipoda	13			A	A	Notonectidae*	3					Empididae	6				
Ph: 4.45	Potamonautidae*	3					Pleidae*	4					Ephyridae	3				
DO: mg/l	Atyidae	8					Veliidae/M...veliidae*	5		A	A	A	Muscidae	1				
Cond: 44 mS/m	Palaemonidae	10					MEGALOPTERA :						Psychodidae	1				
BIOTOPES SAMPLED :	HYDRACARINA	8					Cordalidae	8					Simuliidae	5				
SIC: TIME: minutes	PLECOPTERA :						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5				
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1sp	4		A	A	A	Hydropsychidae 1sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6					Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphocen.	8					Planorbidae*	3				
FLOW: Highest in sampling period.	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY :	Oligoneuridae	15					Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA :						Lepidostomatidae	10					SASS SCORE:		0	33	34	54
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		0	7	6	10
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		0.00	0.00	5.67	5.40
	Chlorolestidae	8					Pisuliidae	10					IHAS :		39%			
	Coenagrionidae	4		A		A	Sericostomatidae SWC	13					OTHER BIOTA :					
	Lestidae	8					COLEOPTERA :											
SIGNS OF POLLUTION:	Platynemidae	10					Dytiscidae*	5		A		A	COMMENTS :					
	Protonemidae	8					Elmidae/Dryopidae*	8					* = airbreathers					
	Zygoptera juvs.	6					Gyrinidae*	5					SWC = South Western Cape					
	Aeshnidae	8		A		A	Halipidae*	5					T = Tropical					
	Corduliidae	8					Helodidae	12					ST = Sub-tropical					
OTHER OBSERVATIONS:	Gomphidae	6			A	A	Hydraenidae*	8					S = Stone & rock					
Mostly mud in GSM . Recent heavy rains.	Libellulidae	4		A	A	A	Hydrophilidae*	5					VG = all vegetation					
	LEPIDOPTERA :						Limnichidae	10					GSM = gravel, sand & mud					
	Pvralidae	12					Psephenidae	10					1=1 A=2-10, B=10-100, C=100-1000, D=>1000					

Appendix C-xii

HAV1 REPL-T4/5 BOREHOLES S21(C)-(I) MONITORING REPORT JAN-SEP 2025

DATE: 30/06/25	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT	TAXON		S	VG	GSM	TOT
GRID REFERENCE:	PORIFERA	5					HEMIPTERA:						DIPTERA:					
S: °	COELENTERATA	1					Belostomatidae*	3					Athericidae	10				
E: °	TURBELLARIA	3					Corixidae*	3					Blepharoceridae	15				
SITE CODE: T4/5 downstream	ANNELIDA:						Gerridae*	5					Ceratopogonidae	5				
RIVER:	Oligochaeta	1					Hydrometridae*	6					Chironomidae	2	1	A		A
SITE DESCRIPTION:	Leeches	3					Naucoridae*	7					Culicidae*	1				
WEATHER CONDITION:	CRUSTACEA:						Nepidae*	3					Dixidae*	10				
TEMP: 13.0 °C	Amphipoda	13	A			A	Notonectidae*	3			1	1	Empididae	6				
Ph: 5.09	Potamonautidae*	3					Pleidae*	4					Ephyridae	3				
DO: mg/l	Atyidae	8					Veliidae/M. veliidae*	5		A	A	A	Muscidae	1				
Cond: 54.0 mS/m	Palaemonidae	10					MEGALOPTERA:						Psychodidae	1				
BIOTOPES SAMPLED:	HYDRACARINA	8					Cordalidae	8					Simuliidae	5		B	A	B
SIC: TIME: minutes	PLECOPTERA:						Sialidae	6					Syrphidae*	1				
SOOC:	Notonemouridae	14					TRICHOPTERA						Tabanidae	5				
BEDROCK:	Perlidae	12					Dipseudopsidae	10					Tipulidae	5			1	1
AQUATIC VEG: DOM SP:	EPHEMEROPTERA						Ecnomidae	8					GASTROPODA					
M VEG IC: DOM SP:	Baetidae 1sp	4			A	A	Hydropsychidae 1sp	4					Ancylidae	6				
M VEG OOC: DOM SP:	Baetidae 2 sp	6					Hydropsychidae 2 sp	6					Bulininae*	3				
GRAVEL:	Baetidae >2 sp	12					Hydropsychidae >2 sp	12					Hydrobiidae*	3				
SAND:	Caenidae	6			1	1	Philopotamidae	10					Lymnaeidae*	3				
MUD:	Ephemeridae	15					Polycentropodidae	12					Physidae*	3				
HAND PICKING/VISUAL OBS:	Heptageniidae	13					Psychomyiidae/Xiphoc. cen.	8					Planorbidae*	3				
FLOW: High	Leptophlebiidae	9					CASED CADDIS:						Thiaridae*	3				
TURBIDITY: Clear water	Oligoneuridae	15	A			A	Barbarochthonidae SWC	13					Viviparidae* ST	5				
RIPARIAN LAND USE:	Polymitarcyidae	10					Calamoceratidae ST	11					PELECYPODA					
	Prosopistomatidae	15					Glossosomatidae SWC	11					Corbiculidae	5				
	Teloganodidae SWC	12					Hydroptilidae	6					Sphaeriidae	3				
	Tricorythidae	9					Hydrosalpingidae SWC	15					Unionidae	6				
	ODONATA:						Lepidostomatidae	10					SASS SCORE:		43	26	43	87
DISTURBANCE IN RIVER:	Calopterygidae ST,T	10					Leptoceridae	6					NO OF TAXA:		6	6	9	15
	Chlorocyphidae	10					Petrothrincidae SWC	11					ASPT:		0.00	4.33	4.78	5.80
	Chlorolestidae	8					Pisuliidae	10					IHAS:		46%			
	Coenagrionidae	4	A	1		A	Sericostomatidae SWC	13					OTHER BIOTA:					
	Lestidae	8					COLEOPTERA:						COMMENTS:					
SIGNS OF POLLUTION:	Platynemidae	10					Dytiscidae*	5		A		A	* = airbreathers					
	Protonuridae	8					Elmidae/Dryopidae*	8					SWC = South Western Cape					
	Zygoptera juvs.	6					Gyrinidae*	5		1	1	1	T = Tropical					
	Aeshnidae	8					Halipidae*	5					ST = Sub-tropical					
	Corduliidae	8					Helodidae	12					S = Stone & rock					
OTHER OBSERVATIONS:	Gomphidae	6			A	A	Hydraenidae*	8					VG = all vegetation					
Large amount of runs.	Libellulidae	4	A		A	A	Hydrophilidae*	5	1			1	GSM = gravel, sand & mud					
	LEPIDOPTERA:						Limnichidae	10					1=1, A=2-10, B=10-100, C=100-1000, D=>1000					
	Pyralidae	12					Psephenidae	10										

HAV1 REPL-T4/5 BOREHOLES S21(C)-(I) MONITORING REPORT JAN-SEP 2025

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)							
River Name : Seasonal Stream of the Onrus River		Date : 03/04/2025					
Site Name : HAV1repl upstream							
SAMPLING HABITAT		0	1	2	3	4	5
STONES IN CURRENT (SIC)							
Total length of white water rapids (i.e.: bubbling water) (in meters)		none	0-1	>12	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)		none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)		0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)		none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*		n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min) (* NOTE: up to 25% of stone is usually embedded in the stream bottom)		0	<1	>12	2	>2-3	>3
		SIC Score (max 20): 0					
VEGETATION		0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)		none	0-½	>½1	>12	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)		none	0-½	>½1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)		none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)		none		1-25	26-50	51-75	>75
		Vegetation Score (max 15): 0					
OTHER HABITAT/GENERAL		0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)		none	0-½	>½1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)		none	under	0-½	>½1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)		none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**		none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**		none	some			all**	
Algae present: ('12m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***		>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'cor' = correct time)			under		corr		over
		Other Habitat Score (max 20): 11					
		HABITAT TOTAL (MAX 55): 11					
STREAM CONDITION		0	1	2	3	4	5
PHYSICAL							
River make up: ('pool' = pool/still/dam only; 'run' only; etc)		pool		run	rapid	2mix	3mix
Average width of stream: (in meters)			>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)		>1	1	>½1	½	<½¼	<¼
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)		still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)		silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***		fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)		none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***		erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)		0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)		0-50	50-80	81-95	>95		
(** NOTE: if more than one option, choose the lowest)							
		STREAM CONDITIONS TOTAL (MAX 23)					
		TOTAL IHAS SCORE (%): 34					

HAV1 REPL-T4/5 BOREHOLES S21(C)-(I) MONITORING REPORT JAN-SEP 2025

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)							
River Name : Seasonal Stream of the Onrus River		Date : 03/04/2025 - Not assessed as dry					
Site Name : HAV1repl downstream							
SAMPLING HABITAT		0	1	2	3	4	5
STONES IN CURRENT (SIC)							
Total length of white water rapids (i.e.: bubbling water) (in meters)		none	0-1	>12	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)		none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)		0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)		none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*		n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min) (* NOTE: up to 25% of stone is usually embedded in the stream bottom)		0	<1	>12	2	>2-3	>3
		SIC Score (max 20): 0					
VEGETATION		0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)		none	0-½	>½1	>12	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)		none	0-½	>½1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)		none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)		none		1-25	26-50	51-75	>75
		Vegetation Score (max 15): 0					
OTHER HABITAT/GENERAL		0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)		none	0-½	>½1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)		none	under	0-½	>½1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)		none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**		none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**		none	some			all**	
Algae present: ('12m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***		>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'corr' = correct time)			under		corr		over
		Other Habitat Score (max 20): 0					
		HABITAT TOTAL (MAX 55): 0					
STREAM CONDITION		0	1	2	3	4	5
PHYSICAL							
River make up: ('pool' = pool/still/dam only; 'run' only; etc)		pool		run	rapid	2mix	3mix
Average width of stream: (in meters)			>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)		>1	1	>½1	½	<½¼	<¼
Approximate velocity of stream: ('slow' = <¼m/s; 'fast' = >1m/s) (use twig to test)		still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)		silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***		fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)		none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***		erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)		0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)		0-50	50-80	81-95	>95		
(** NOTE: if more than one option, choose the lowest)							
		STREAM CONDITIONS TOTAL (MAX 40)					
		TOTAL IHAS SCORE (%): 0					

HAV1 REPL-T4/5 BOREHOLES S21(C)-(I) MONITORING REPORT JAN-SEP 2025

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name : Perennial stream of the Onrus River						
Site Name : T4/5 upstream	Date : 03/04/2025					
SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>12	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min) (* NOTE: up to 25% of stone is usually embedded in the stream bottom)	0	<1	>12	2	>2-3	>3
SIC Score (max 20):						0
VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½1	>12	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none		1-25	26-50	51-75	>75
Vegetation Score (max 15):						0
OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('12m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'cor' = correct time)		under		corr		over
Other Habitat Score (max 20):						11
HABITAT TOTAL (MAX 55):						11
STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>1	1	>½1	½	<½¼	<¼
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	50-80	81-95	>95		
STREAM CONDITIONS TOTAL (MAX 23)						
TOTAL IHAS SCORE (%):						34

HAV1 REPL-T4/5 BOREHOLES S21(C)-(I) MONITORING REPORT JAN-SEP 2025

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name : Perennial stream of the Onrus River						
Site Name : T4/5 downstream	Date : 03/04/2025					
SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>12	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min) (* NOTE: up to 25% of stone is usually embedded in the stream bottom)	0	<1	>12	2	>2-3	>3
SIC Score (max 20):			0			
VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½1	>12	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none		1-25	26-50	51-75	>75
Vegetation Score (max 15):			13			
OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('12m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'cor' = correct time)		under		corr		over
Other Habitat Score (max 20):			12			
HABITAT TOTAL (MAX 55):			25			
STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>1	1	>½1	½	<½¼	<¼
Approximate velocity of stream: ('slow' = <¼m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	50-80	81-95	>95		
STREAM CONDITIONS TOTAL (MAX 25)						
TOTAL IHAS SCORE (%):			50			

HAV1 REPL-T4/5 BOREHOLES S21(C)-(I) MONITORING REPORT JAN-SEP 2025

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name : Seasonal Stream of the Onrus River						
Site Name : HAV1repl upstream	Date : 05/05/2025					
SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>12	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min) (* NOTE: up to 25% of stone is usually embedded in the stream bottom)	0	<1	>12	2	>2-3	>3
SIC Score (max 20):						0
VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>12	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none		1-25	26-50	51-75	>75
Vegetation Score (max 15):						5
OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'corr' = correct time)		under		corr		over
Other Habitat Score (max 20):						12
HABITAT TOTAL (MAX 55):						17
STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>1	1	>½-1	½	<½-¼	<¼
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	50-80	81-95	>95		
STREAM CONDITIONS TOTAL (MAX 33)						
TOTAL IHAS SCORE (%):						50

HAV1 REPL-T4/5 BOREHOLES S21(C)-(I) MONITORING REPORT JAN-SEP 2025

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name : Perennial stream of the Onrus River						
Site Name : T4/5 upstream	Date : 05/05/2025					
SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>12	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min) (* NOTE: up to 25% of stone is usually embedded in the stream bottom)	0	<1	>12	2	>2-3	>3
SIC Score (max 20):						0
VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>12	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none		1-25	26-50	51-75	>75
Vegetation Score (max 15):						10
OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('12m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'corr' = correct time)		under		corr		over
Other Habitat Score (max 20):						13
HABITAT TOTAL (MAX 55):						23
STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>1	1	>½-1	½	<½-¼	<¼
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	50-80	81-95	>95		
STREAM CONDITIONS TOTAL (MAX 24)						
TOTAL IHAS SCORE (%):						47

HAV1 REPL-T4/5 BOREHOLES S21(C)-(I) MONITORING REPORT JAN-SEP 2025

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name : Perennial stream of the Onrus River						
Site Name : T4/5 downstream	Date : 05/05/2025					
SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>12	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min) (* NOTE: up to 25% of stone is usually embedded in the stream bottom)	0	<1	>12	2	>2-3	>3
SIC Score (max 20):			10			
VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>12	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none		1-25	26-50	51-75	>75
Vegetation Score (max 15):			7			
OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'corr' = correct time)		under		corr		over
Other Habitat Score (max 20):			13			
HABITAT TOTAL (MAX 55):			30			
STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>1	1	>½-1	½	<½-¼	<¼
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	50-80	81-95	>95		
STREAM CONDITIONS TOTAL (MAX 30)						
TOTAL IHAS SCORE (%):			60			

HAV1 REPL-T4/5 BOREHOLES S21(C)-(I) MONITORING REPORT JAN-SEP 2025

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)							
River Name : Seasonal Stream of the Onrus River		Date : 30/06/25					
Site Name : HAV1repl upstream							
SAMPLING HABITAT		0	1	2	3	4	5
STONES IN CURRENT (SIC)							
Total length of white water rapids (i.e.: bubbling water) (in meters)		none	0-1	>1-2	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)		none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)		0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)		none	<2>20	2-10	11-20	21-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*		n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min) (* NOTE: up to 25% of stone is usually embedded in the stream bottom)		0	<1	>1-2	2	>2-3	>3
		SIC Score (max 20): 6					
VEGETATION		0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)		none	0-½	>½-1	>1-2	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)		none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)		none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)		none		1-25	26-50	51-75	>75
		Vegetation Score (max 15): 6					
OTHER HABITAT/GENERAL		0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)		none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)		none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)		none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**		none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**		none	some			all**	
Algae present: ('1-2m² = algal bed; 'rocks' = on rocks; 'iso' = isolated clumps)***		>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'cor' = correct time)			under		corr		over
(** NOTE: you must still fill in the SIC section)							
		Other Habitat Score (max 20): 16					
		HABITAT TOTAL (MAX 55): 28					
STREAM CONDITION		0	1	2	3	4	5
PHYSICAL							
River make up: ('pool' = pool/still/dam only; 'run' only; etc)		pool		run	rapid	2mix	3mix
Average width of stream: (in meters)			>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)		>1	1	>½-1	½	<½-¼	<¼
Approximate velocity of stream: ('slow' = <¼m/s; 'fast' = >1m/s) (use twig to test)		still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)		silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***		fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)		none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***		erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)		0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)		0-50	50-80	81-95	>95		
(** NOTE: if more than one option, choose the lowest)							
		STREAM CONDITIONS TOTAL (MAX 28)					
		TOTAL IHAS SCORE (%): 56					

HAV1 REPL-T4/5 BOREHOLES S21(C)-(I) MONITORING REPORT JAN-SEP 2025

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)							
River Name : Seasonal Stream of the Onrus River		Date : 30/06/25					
Site Name : HAV1repl downstream							
SAMPLING HABITAT		0	1	2	3	4	5
STONES IN CURRENT (SIC)							
Total length of white water rapids (i.e.: bubbling water) (in meters)		none	0-1	>12	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)		none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)		0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)		none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*		n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min) (* NOTE: up to 25% of stone is usually embedded in the stream bottom)		0	<1	>12	2	>2-3	>3
		SIC Score (max 20): 0					
VEGETATION		0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)		none	0-½	>½1	>12	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)		none	0-½	>½1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)		none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)		none		1-25	26-50	51-75	>75
		Vegetation Score (max 15): 11					
OTHER HABITAT/GENERAL		0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)		none	0-½	>½1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)		none	under	0-½	>½1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)		none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**		none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**		none	some			all**	
Algae present: ('12m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***		>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'cor' = correct time)			under		corr		over
		Other Habitat Score (max 20):					
		HABITAT TOTAL (MAX 55): 17					
STREAM CONDITION		0	1	2	3	4	5
PHYSICAL							
River make up: ('pool' = pool/still/dam only; 'run' only; etc)		pool		run	rapid	2mix	3mix
Average width of stream: (in meters)			>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)		>1	1	>½1	½	<½¼	<¼
Approximate velocity of stream: ('slow' = <¼m/s; 'fast' = >1m/s) (use twig to test)		still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)		silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***		fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)		none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***		erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)		0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)		0-50	50-80	81-95	>95		
(** NOTE: if more than one option, choose the lowest)							
		STREAM CONDITIONS TOTAL (MAX 22)					
		TOTAL IHAS SCORE (%): 39					

HAV1 REPL-T4/5 BOREHOLES S21(C)-(I) MONITORING REPORT JAN-SEP 2025

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)							
River Name : Perennial stream of the Onrus River		Date : 30/06/25					
Site Name : T4/5 upstream							
SAMPLING HABITAT		0	1	2	3	4	5
STONES IN CURRENT (SIC)							
Total length of white water rapids (i.e.: bubbling water) (in meters)		none	0-1	>12	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)		none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)		0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)		none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*		n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min) (* NOTE: up to 25% of stone is usually embedded in the stream bottom)		0	<1	>12	2	>2-3	>3
		SIC Score (max 20): 0					
VEGETATION		0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)		none	0-½	>½1	>12	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)		none	0-½	>½1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)		none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)		none		1-25	26-50	51-75	>75
		Vegetation Score (max 15): 7					
OTHER HABITAT/GENERAL		0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)		none	0-½	>½1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)		none	under	0-½	>½1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)		none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**		none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**		none	some			all**	
Algae present: ('12m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***		>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'corr' = correct time)			under		corr		over
		Other Habitat Score (max 20): 14					
		HABITAT TOTAL (MAX 55): 21					
STREAM CONDITION		0	1	2	3	4	5
PHYSICAL							
River make up: ('pool' = pool/still/dam only; 'run' only; etc)		pool		run	rapid	2mix	3mix
Average width of stream: (in meters)			>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)		>1	1	>½1	½	<½¼	<¼
Approximate velocity of stream: ('slow' = <½m/s; 'fast' = >1m/s) (use twig to test)		still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)		silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***		fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)		none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***		erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)		0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)		0-50	50-80	81-95	>95		
(** NOTE: if more than one option, choose the lowest)							
		STREAM CONDITIONS TOTAL (MAX 27)					
		TOTAL IHAS SCORE (%): 48					

HAV1 REPL-T4/5 BOREHOLES S21(C)-(I) MONITORING REPORT JAN-SEP 2025

INVERTEBRATE HABITAT ASSESSMENT SYSTEM (IHAS)						
River Name : Perennial stream of the Onrus River						
Site Name : T4/5 downstream	Date : 30/06/25					
SAMPLING HABITAT	0	1	2	3	4	5
STONES IN CURRENT (SIC)						
Total length of white water rapids (i.e.: bubbling water) (in meters)	none	0-1	>12	>2-3	>3-5	>5
Total length of submerged stones in current (run) (in meters)	none	0-2	>2-5	>5-10	>10	
Number of separate SIC area's kicked (not individual stones)	0	1	2-3	4-5	6+	
Average stone size's kicked (cm's) (gravel is <2, bedrock is >20)	none	<2>20	2-10	11-20	2-20	
Amount of stone surface clear (of algae, sediment, etc) (in %)*	n/a	0-25	26-50	51-75	>75	
PROTOCOL: time spent actually kicking stones (in minutes) (gravel/bedrock = 0 min) (* NOTE: up to 25% of stone is usually embedded in the stream bottom)	0	<1	>12	2	>2-3	>3
			SIC Score (max 20): 8			
VEGETATION	0	1	2	3	4	5
Length of fringing vegetation sampled (river banks) (PROTOCOL - in meters)	none	0-½	>½-1	>12	2	>2
Amount of aquatic vegetation sampled (underwater) (in square meters)	none	0-½	>½-1	>1		
Fringing vegetation sampled in: ('still' = pool/still water only; 'run' = run only)	none		run	pool		mix
Type of vegetation (% leafy veg. As opposed to stems/shoots) (aq. Veg. Only = 49%)	none		1-25	26-50	51-75	>75
			Vegetation Score (max 15): 16			
OTHER HABITAT/GENERAL	0	1	2	3	4	5
Stones out of current (SOOC) sampled: (PROTOCOL - in square meters)	none	0-½	>½-1	1	>1	
Sand sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	>½-1	1	>1
Mud sampled: (PROTOCOL - in minutes) ('under' = present, but only under stones)	none	under	0-½	½	>½	
Gravel sampled: (PROTOCOL - in minutes) (if all gravel, SIC stone size = <2)**	none	0-½	½	>½**		
Bedrock sampled: ('all' = no SIC, sand, or gravel then SIC stone size = >20)**	none	some			all**	
Algae present: ('12m² = algal bed; 'rocks' = on rocks; 'isol' = isolated clumps)***	>2m²	rocks	1-2m²	<1m²	isol	none
Tray identification: (PROTOCOL - using time: 'coor' = correct time)		under		corr		over
			Other Habitat Score (max 20): 16			
			HABITAT TOTAL (MAX 55): 40			
STREAM CONDITION	0	1	2	3	4	5
PHYSICAL						
River make up: ('pool' = pool/still/dam only; 'run' only; etc)	pool		run	rapid	2mix	3mix
Average width of stream: (in meters)		>10	>5-10	<1	1-2	>2-5
Average depth of stream: (in meters)	>1	1	>½-1	½	<½-¼	<¼
Approximate velocity of stream: ('slow' = <¼m/s; 'fast' = >1m/s) (use twig to test)	still	slow	fast	med		mix
Water colour: ('disc' = discoloured with visible colour but still transparent)	silty	opaque		disc		clear
Recent disturbance due to: ('const.' = construction; 'fl/dr' = flood or drought)***	fl/dr	fire	constr	other		none
Bank/riparian vegetation is: ('grass' = includes reeds; 'shrubs' = include trees)	none		grass	shrubs	mix	
Surrounding impacts: ('erosn' = erosion/shear bank; 'farm' = farmland/settlement)***	erosn	farm	trees	other		open
Left bank cover: (rocks and vegetation) (in %)	0-50	51-80	81-95	>95		
Right bank cover: (rocks and vegetation) (in %)	0-50	50-80	81-95	>95		
			STREAM CONDITIONS TOTAL (MAX 30)			
			TOTAL IHAS SCORE (%): 70			