RESERVE DETERMINATION STUDY FOR SELECTED SURFACE WATER, GROUNDWATER, ESTUARIES AND WETLANDS IN THE F60 AND G30 CATCHMENTS WITHIN THE BERG-OLIFANTS WMA

EWR SITE SURVEY REPORT

April 2022







Department of Water and Sanitation

Chief Directorate: Water Ecosystem Management

DEPARTMENT: WATER AND SANITATION

CHIEF DIRECTORATE: WATER ECOSYSTEM MANAGEMENT

RESERVE DETERMINATION STUDY FOR SELECTED SURFACE WATER, GROUNDWATER, ESTUARIES AND WETLANDS IN THE F60 AND G30 CATCHMENTS WITHIN THE BERG-OLIFANTS WMA

WP11340

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Prepared by:

BlueScience (Pty) Ltd, Editors: Belcher, T and Grobler, D
In association with: GEOSS (Pty) Ltd, Zutari (Pty) Ltd, CSIR, Nelson Mandela University, University of Stellenbosch, Dr Linda Rossouw & Mr N Rossouw, Mr Dean Ollis, Mr Dean Impson, Mr Tony Barbour and Dr Charles Boucher.

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CONTRIBUTING AUTHORS:	T Barbour, M Burger, J Conrad, L Dobinson, D Impson, D Ollis, L Rossouw, N Rossouw, L Smit, S Taljaard, A Watson and L van Niekerk
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……..

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DOCUMENT INDEX

Reports as part of this project:

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ACRONYMS AND ABBREVIATIONS

DWS	Department of Water and Sanitation
EC	Electrical Conductivity
EcoStatus	Ecological Status
EGSA	Ecosystem Goods, Services and Attributes
EIS	Ecological Importance and Sensitivity
EWR	Ecological Water Requirements
GIS	Geographic Information System
GRU	Groundwater Resource Unit
HGM	Hydrogeomorphic
HRU	Hydrological Resource Unit
IHI	Index of Habitat Integrity
l/s	Litre per second
mS/m	milliSiemens per meter (measurement of the electrical conductivity of water)
MSL	Mean Sea Level
PES	Present Ecological State
ppt	parts per thousand (measurement of salinity)
REI	River Estuary Interface
REMP	River EcoStatus Monitoring Programme
TMG	Table Mountain Group
VEGRAI	Vegetation Response Assessment Index

GLOSSARY

ANTHROPOGENIC	Caused by human activity
AQUATIC	Relating to water
AQUIFER	Underground layer of water-bearing permeable rock, rock fractures or unconsolidated materials (gravel, sand, or silt)
ATTENUATION	To make something weaker or have less effect.
BASEFLOW	That part of stream flow contributed by groundwater and discharged gradually into the channel.
BENTHIC	Organisms that inhabit the shallow, bottom habitat of water.
BIOTA	The living organisms occupying a place together, e.g., plants, animals, bacteria, etc in the aquatic biota, or terrestrial biota.
BIOMONITORING	Monitoring of living organisms, usually as indicators of habitat integrity
CALCAREOUS	Composed of, containing, or characteristic of calcium carbonate, calcium, or limestone
CATCHMENT	The area from which any rainfall will drain into the watercourse or watercourses, through surface or subsurface flow.
CONTAMINANT	A foreign agent that is present (e.g., in water, sediment) that may produce a physical or chemical change but may not cause an adverse biological effect
DIFFUSE SOURCE	A general source (e.g., of pollution), the exact location of which is difficult to pinpoint.
DISTURBANCE REGIME	The pattern of natural variability of physical and biological processes, incorporating the return time to a stable condition from extreme conditions.
ECOCLASSIFICATION	The term used for Ecological Classification refers to the determination and categorisation of the Present Ecological State (PES; health or integrity) of various biophysical attributes of rivers compared to the natural or close to natural reference condition. The purpose of EcoClassification is to gain insights into the causes and sources of the deviation of the PES of biophysical

	attributes from the reference condition. This provides the information needed to derive desirable and attainable future ecological objectives for the river. The EcoClassification process also supports a scenario-based approach where a range of ecological endpoints have to be considered.
ECOLOGICAL HEALTH	A descriptive non-specific term for the combination of all factors, biotic and abiotic, that make up a particular environment and its organisms
ECOREGIONS	Areas of similar ecological characteristics.
ECOSYSTEM	A community of animals, plants and bacteria with its physical and chemical environment.
EPHEMERAL	An ephemeral stream has flowing water only during, and for a short duration after, precipitation events in a typical year
ENVIRONMENT	All of the external factors, conditions, and influences that affect the growth, development, and survival of organisms or a community. This includes climate, physical, chemical, and biological factors, nutrients, and social and cultural conditions.
EROSION	The wearing away and removal of materials of the earth's crust by natural means. Running water, waves, moving ice, and wind currents are examples of erosion.
ESTUARY	A partially or fully enclosed body of water that is open to the sea permanently or periodically, and within which the sea water can be diluted, to a measurable extent, with fresh water drained from land.
EUTROPHICATION	The process whereby high levels of nutrients result in the excessive growth of plants.
FLOW REGIME	Recorded or historical sequence of flows used to create a hydrological profile of the water resource.
GEOMORPHOLOGY	The branch of geology that deals with, amongst other things, the form of the earth and the changes that take place in the process of development of landforms.
GRADIENT	The degree of slope or incline. In the context of this course, it refers to the slope of a stream bed or the vertical distance that water falls while travelling a horizontal distance downstream.
GYPSIFEROUS	Containing or yielding gypsum

HABITAT	The environment or place where a plant or animal is most likely to occur naturally.
HYDRAULICS	Of, involving, moved by, or operated by a fluid, especially water, under pressure.
HYDROLOGY	The scientific study of the properties, distribution, and effects of water on the earth's surface, in the soil and underlying rocks, and in the atmosphere.
HYPERSALINE	An environment that has salinities greater than that of normal seawater
IMPACTS	The measurable effect of one thing on another.
IMPOUNDMENT	To retain water artificially by means of a weir or dam.
INDICATOR SPECIES	A species that has been extensively studied to the point that the effect of environmental changes upon its distribution and lifecycle are well known so that knowledge of its status provides information on the overall condition of the ecosystem, and of other species in that ecosystem.
INDIGENOUS	Living or growing naturally in a particular area, but not naturally confined only to that area or any resource consisting of (a) any living or dead animal, plant or other organisms of an indigenous species, (b) any derivative of such animal, plant or other organisms; or (c) any genetic material of such animal, plant or other organisms.
INDIGENOUS SPECIES	A species that occurs, or has historically occurred, naturally in a free state, in nature within an ecologically similar area, but excludes a species that has been introduced from another area or continent as a result of human activity
INTERGRANULAR AQUIFER	An aquifer in which groundwater flows in openings and void space between grains or weathered rock
INVERTEBRATE	Animal without a backbone
KARST AQUIFERS	Aquifers that occur within limestone geology, where the limestone (or other easily dissolved rock) has been partially dissolved so that some fractures are enlarged into passages that carry the groundwater flow
MODIFIED	Changed, altered.

NUTRIENTS	Elements required for life processes: nitrogen, phosphorus and potassium are probably the most important nutrients.
POINT SOURCE	A definable or precise location or source e.g., of pollution
PRISTINE	Remaining in a pure or natural state.
PREDATION	A predator is an animal that kills and eats other animals. Predation is the capturing of prey as a means of maintaining life.
PRESENT ECOLOGICAL STATE	The current state or condition of a resource in terms of its various components, i.e., drivers (physico-chemical, geomorphology, and hydrology) and biological response (fish, riparian vegetation and aquatic invertebrates). The prequel to recommended ecological category
QUATERNARY CATCHMENT	A fourth-order catchment in a hierarchical system in which the primary catchment is the major unit.
RIPARIAN	Of, on, or relating to the banks of a water course, including the physical structure and associated vegetation. The area of land adjacent to a stream or river that is influenced by stream-induced or related processes.
RIVER ESTUARY INTERFACE	That part of an estuary where the river and estuarine waters mix, and where the vertically integrated salinity is usually less than 10 ppt
SEDIMENTATION	The act or process of depositing sediment. Sediment comprises fragments of inorganic or organic material that are carried and deposited by water.
SPECIES	A kind of animal, plant or other organisms that does not normally interbreed with individuals of another kind, and includes any sub-species, cultivar, variety, geographic race, strain, hybrid or geographically separate population
TAXON	Biological category (e.g., species) or its name
SUBSTRATE	The surface to which a plant or animal is attached or on which it grows.
SURFACE WATER	All water that is exposed to the atmosphere, e.g., rivers, reservoirs, ponds, the sea, etc.
VARIABILITY	The tendency to vary i.e., to change.

WATERCOURSE	“A natural channel or depression in which water flows regularly or intermittently” (definition in the NWA)
WATER QUALITY	The value or usefulness of water, determined by the combined effects of its physical attributes and its chemical constituents and varying from user to user
WETLANDS	“Land which is transitional between terrestrial and aquatic systems where the water table is usually at, or near the surface or the land is periodically covered with shallow water and which land in normal circumstances supports, or would support vegetation typically adapted to life in saturated soil” (definition in the NWA)

1. INTRODUCTION

1.1 Background

The Chief Directorate: Water Ecosystems Management of the Department of Water and Sanitation (DWS) has embarked on a preliminary Reserve determination study for the G30 and F60 catchments (Figure 1). These are the two remaining Tertiary Catchments of the Berg Olifants Water Management Area (WMA) that still require a higher level of confidence Reserve determination. The Verlorevlei within the study area was designated as a Wetland of International Importance (Ramsar Site) on 28 June 1991 under the Ramsar Convention on Wetlands of International Importance, Especially as Waterfowl Habitat. In addition, peat wetlands have been identified to occur in the area that is associated with the Verlorevlei that provide important ecological services but are under severe threat and require urgent protection. It is therefore crucial that the Reserve calculations are revisited and the water resources with the Sandveld catchments addressed holistically, with a clear understanding of the surface and groundwater interactions and interdependencies being well researched and documented.

1.2 Objectives

This study aims to identify gaps in previous Reserve Determination Studies and to determine the Reserve at a high level of confidence to yield results that could be gazetted and provide legal protection specifications. The following objectives are listed:

1. Determination of the water quantity and quality for the protection of rivers at various Ecological Water Requirement (EWR) sites;
2. Determination of the water quantity and quality for the protection of priority wetlands, pans and lakes;
3. Determination of the water quantity and quality of estuarine freshwater requirements for the protection of various identified estuaries;
4. Determination of the groundwater quantity and quality requirements for the protection of groundwater resources; and
5. Determination of the quantity and quality of water required for the provision of Basic Human Needs.

1.3 Purpose of this Report

The purpose of this report is to describe and document the data collection for the dry season survey of the water resources in the G30 and F60 catchments (Figure 1) of the Olifants-Doorn Water Management Area. This task, therefore, describes the physical, chemical and biological condition of the surface water ecosystems at the selected EWR sites. The report currently only contains the survey results from the first survey undertaken at the end of the dry summer season. The results for the wet season survey at the end of the winter season will be included once the survey has been completed.

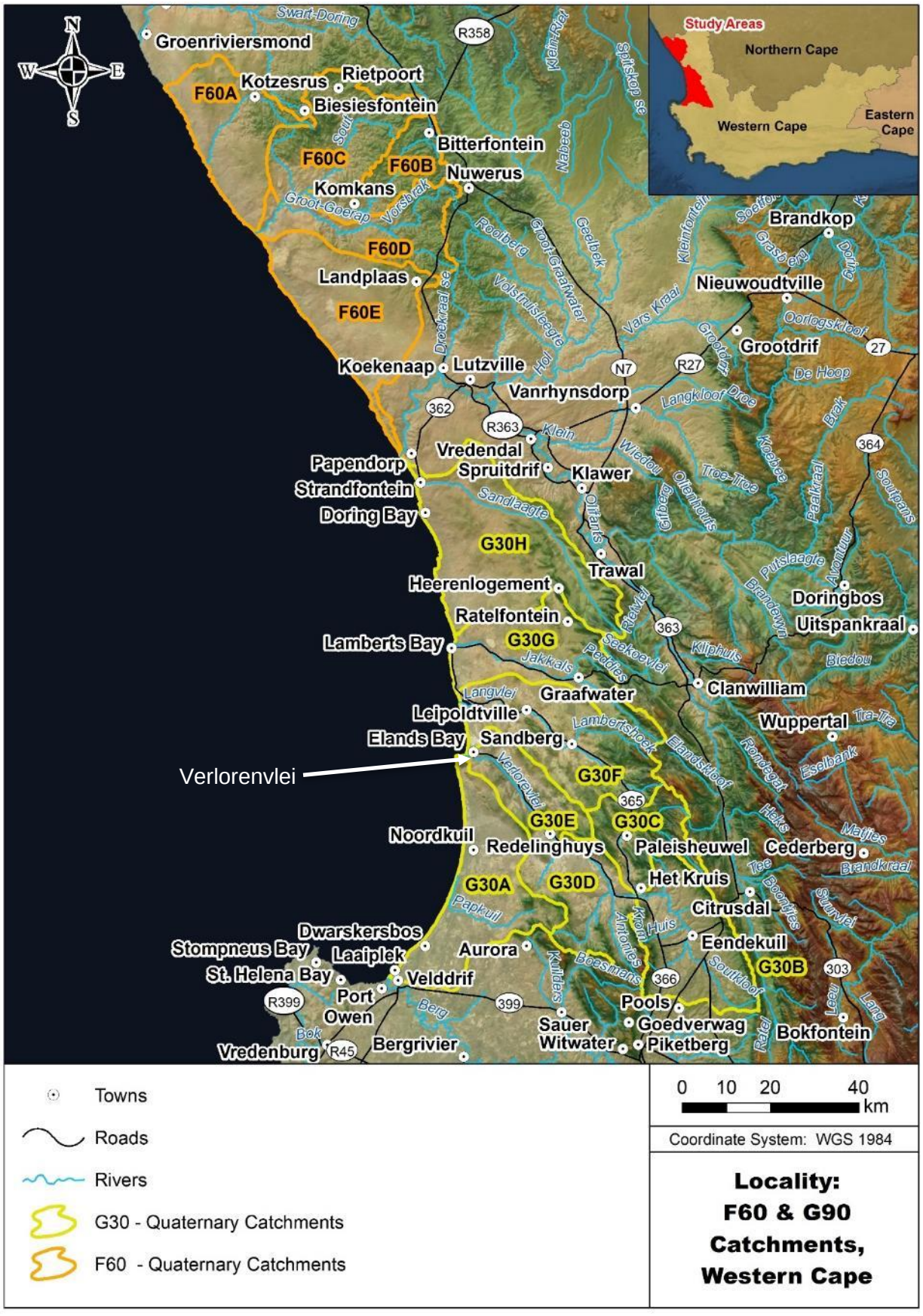


Figure 1: Map of the study area with the location of the G30 and F60 Catchments and main aquatic features shown

1.4. Description of the Study Area

The study area comprises two Tertiary Catchments, the G30 (Sandveld) and the F60 (Knersvlakte) Catchments. The Sandveld consists of the coastal plain along the west coast of South Africa bordered by the Olifants River catchment in the north and east, the Berg River catchment in the south and the Atlantic Ocean coastline in the west.

The area comprises mainly the three parallel seasonal river and longitudinal wetland systems, namely Jakkals, Langvlei and Verlorenvlei. The catchments drain westwards through the Sandveld and consist of a combination of rivers, pans and wetland/vlei systems. Other relatively large wetland areas comprise of Rosherpan near the Berg River Estuary; valley bottom wetland habitats associated with the Papkuil River in G30A; and several pans in the upper Verlorenvlei Catchment. The Ramsar designated Verlorenvlei estuarine and wetland system is the best known of the systems.

The Groot Goerap/Sout and Brak River Catchments to the north of the Sandveld are in the even more arid Knersvlakte region that comprises low, undulating hills with isolated patches of white quartz stone and saline soils.

Although surface water plays a significant role in the study area, particularly for the aquatic ecosystems, groundwater plays a more significant role in sustaining these systems. Groundwater in the G30 (Sandveld) catchment enables extensive agricultural activity and is the sole source of freshwater for most of the towns and settlements within the catchments. The catchments contain both fractured and intergranular areas. The average yield ranges from very low (0.5 l/s) to high yielding (> 5 l/s), with identified paleochannels producing boreholes of a yield higher than 25 l/s. Groundwater quality is good across the G30 catchments (DWAF 2005). Where Malmesbury Group formations occur, the main aquifer can be identified as yielding groundwater of poor quality. The main recharge areas are in the mountainous areas towards the east of the study area that form part of the Cederberg and Piketberg Mountain ranges.

The F60 catchments are overall drier and groundwater availability is much lower than in the G30 catchments. Furthermore, the geological setting of the area is more complex. Quaternary deposits are still present toward the coast but include calcareous and gypsiferous units as well as thick calcrete beds within the deposits. These sediments are underlain by igneous formations that form part of the Bushmanland and Richtersveld Sub-province, which in turn falls under the Namaqua Metamorphic Province. The area has been classified as containing both intergranular and fractured aquifers (DWAF 2005). The regional expected yields are very low (0.1 - 0.5 l/s) with higher-yielding boreholes (up to 2 l/s) at the most southern point of the F60 catchments. Groundwater quality across the catchment is generally categorised as being poor, with EC values of over 1000 mS/m.

Water abstraction from surface and groundwater has significantly modified the flow of the aquatic ecosystems, particularly reducing low flows in summer. Modified flows have reduced, amongst others, the habitat integrity and consequently the goods and services provided by these ecosystems. Land use in the area consists largely of livestock farming (sheep and goats), with small areas being used for dryland farming. Intensive irrigation of citrus and potatoes is undertaken in the south. Urban and rural areas are small, with the main towns being Redelinghuys, Elands Bay, Eendekuil, Leipoldtville, Graafwater, Lamberts Bay, Strandfontein and Bitterfontein

1.5. Selected EWR Sites

The list of EWR sites is provided in Figure 2. Map of the EWR sites for rivers and wetlands in the F60 and G30 Catchments

Table 1, with the rationale for that site selection. Further detail and characteristics for each of the sites are summarised in Table 2 Table 3. Figure 2 shows the locations of the sites on a map of F60 and G60.

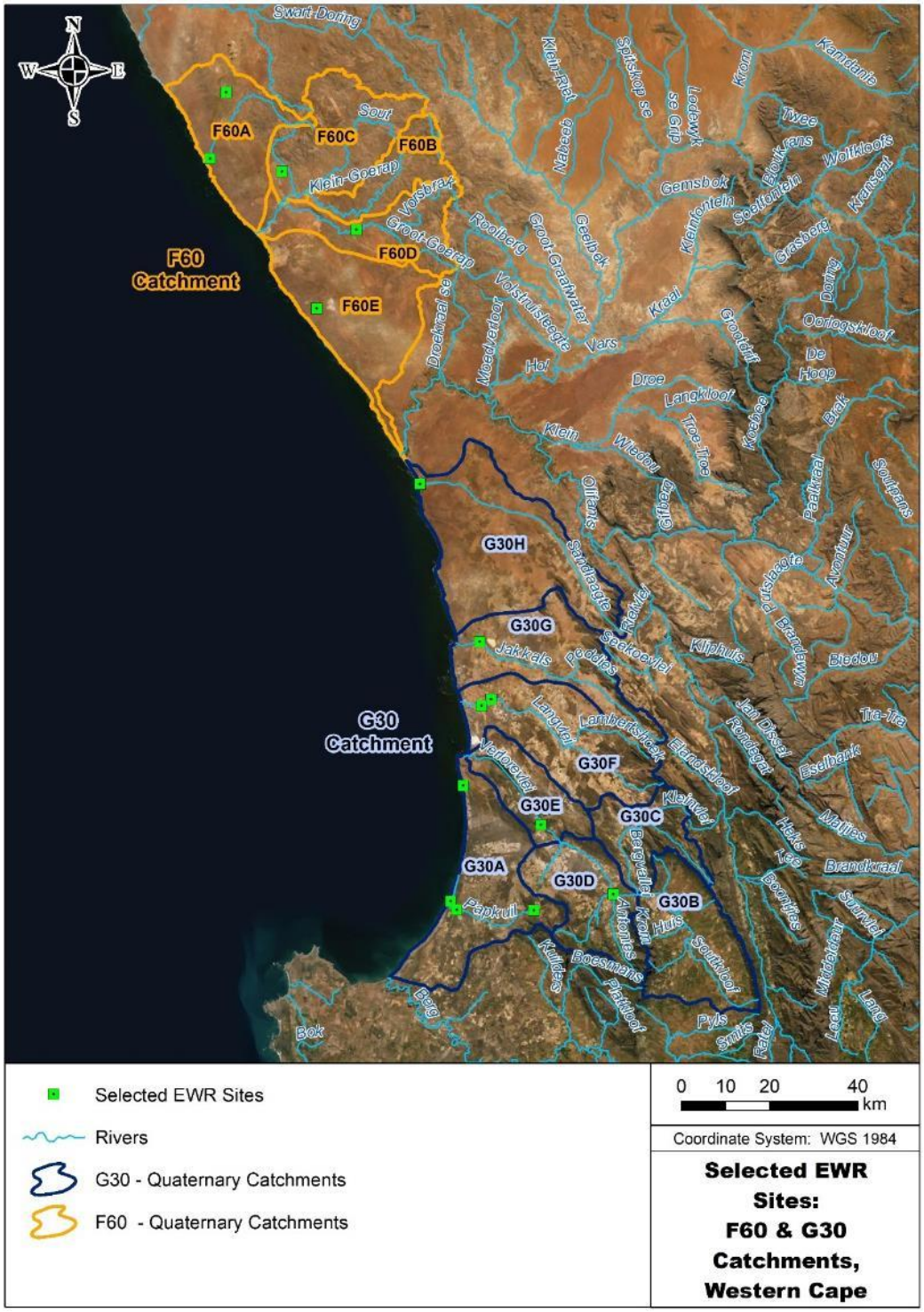


Figure 2. Map of the EWR sites for rivers and wetlands in the F60 and G30 Catchments

Table 1. List of proposed EWR sites and Rationale for selection of proposed River and Wetland EWR sites

EWR Formal site names	Resource Unit	Rationale for site selection
EWR1 RW-F60A BRAK STRAN	Brak River RU; Lower Brak River VB Wetland RU	In the lower Brak River above the estuarine functional zone, relatively unimpacted within a more confined area and contains both river and wetland habitats; access is easy
EWR2 W-F60A DEPR NUWEB	NW Fynbos depression Wetland RU	One of the few FEPA depression wetlands in the NW Fynbos Bioregion within Catchment F60; relatively accessible
EWR3 RW-F60B GRGO KOMKA	Sout/Groot-Goerap River RU	Lowest possible point on the system where access is possible and not impacted; channel also confined
EWR4 W-F60C DEPR ADOON	Knersvlakte depression Wetland RU	The only FEPA depression in the Knersvlakte-Hardeveld Bioregion group within Catchment F60
EWR5 W-F60E DEPR ELSIE	Sandveld depression Wetland RU	A relatively large depression wetland in the Sandveld Bioregion of Catchment F60, which appears to be one of the few depressions in relatively good condition in the Bioregion; relatively accessible
EWR6 RW-G30H SAND HOLLE	Sandlaagte River RU	Lowest possible point on the system where access is possible and not impacted; channel also confined
EWR7 RW-G30G JAKK KOOKF	Jakkals River RU; Lower Jakkals River VB Wetland RU	Lowest possible point on the system where access is possible and not impacted; channel also confined; near long term River Ecostatus monitoring site and near the previous IFR site
EWR8 RW-G30F LANG BRAND	Langvlei River RU; Lower Langvlei VB Wetland RU	Least impacted site on the lower Langvlei that is easily accessible; downstream of a long term River Ecostatus monitoring site and near the previous IFR site
EWR9 W-G30F WADR WAGEN	Wadrift VB Wetland RU	This site was assessed during the previous EWR study in the region and should be re-visited, although the PES of the wetland has become severely degraded
EWR10 RW-G30D KRUI EENHE	Upper Verlorenvlei River RU; Lower Kruismans River VB Wetland RU	Least impacted site on the Kruismans above the confluence with the Krom Antonies and below the confluence of the Kruismans and Bergvallei that is easily accessible and where the channel is relatively confined; downstream of a long term River Ecostatus monitoring site and near the previous IFR site
EWR11 RW-G30D KROM GOERG	Krom Antonies River RU; Krom-Antonies River FP Wetland RU	Least impacted site on the lower Krom Antonies that is easily accessible and where the channel is relatively confined
EWR12 RW-G30E VERL WITTE	Lower Verlorenvlei River RU; Lower Verlorenvlei River FP Wetland RU	Least impacted site on the Verlorenvlei above the estuarine functional zone and below Redelinghuys that is easily accessible and where the channel is relatively confined downstream of a long term River Ecostatus monitoring site and near the previous IFR site
EWR13 W-G30A DUNE FA277	West Strandveld dune slack Wetland RU	A relatively minimally impacted example of a dune slack wetland in the West Strandveld Bioregion, compared to most of the other dune slack wetlands in the region
EWR14 W-G30A ROSH FA272	Rocherpan Wetland RU	A wetland of very high importance for wading birds and for eco-tourism, located within a nature reserve; very easy to access and safe to leave sampling equipment in place
EWR15 RW-G30A PAPK BOOKR	Papkuils River RU; Lower Papkuils FP Wetland RU	Least impacted site on the lower Papkuils River that is easily accessible and where the channel is relatively confined
EWR16 W-G30A PAPK RIETF	Upper Papkuils seep Wetland RU	One of the most extensive seep wetlands (assumed to be of importance for streamflow regulation) in the entire study area, which is of particular significance for sustained water supply to the rest of the Papkuils system

Table 2: Short description and geographical context of proposed River and Wetland EWR sites

EWR Formal site names	Description	Quaternary Catchment	Lat/long	Cadastral
EWR1 RW-F60A BRAK STRAN	Combined river and wetland site immediately upstream of the estuarine functional zone of the Brak River	F60A	31° 5'21.84"S; 17°44'18.66"E	Strandfontein 559 Re
EWR2 W-F60A DEPR NUWEB	Isolated depression wetland	F60A	30°57'31.45"S; 17°46'31.76"E	Nuwe-Begin 641 Re
EWR3 RW-F60B GRGO KOMKA	Combined river and wetland site on the lower Groot Goerap River	F60B	31°14'17.91"S; 18° 5'4.26"E	Ptn 4 of Komkans 141
EWR4 W-F60C DEPR ADOON	Isolated depression wetland	F60C	31° 7'4.19"S; 17°54'29.95"E	Farm RE/641 Nuwe-Begin
EWR5 W-F60E DEPR ELSIE	Isolated depression wetland	F60E	31°23'54.61"S; 17°59'16.63"E	Farm RE/145 Adoonsvlei
EWR6 RW-G30H SAND HOLLE	River site on the lower Sandlaagte River	G30H	31°45'35.93"S; 18°13'53.10"E	Re of Ptn 13, Hollebakstrandfontein 270
EWR7 RW-G30G JAKK KOOKF	Combined river and wetland site immediately upstream of the estuarine functional zone of the Jakkals River	G30G	32° 4'59.30"S; 18°22'20.10"E	Ptn 3 of Kookfontein 88
EWR8 RW-G30F LANG BRAND	Wetland site on the lower Langvlei River	G30F	32°12'5.82"S; 18°23'54.02"E	Ptn 23 of Brandwacht 226
EWR9 W-G30F WADR WAGEN	Wetland site at Wadrif Wetland on the lower Langvlei River	G30F	32°12'52.21"S; 18°22'31.50"E	Wagendrift 230 Re
EWR10 RW-G30D KRUI EENHE	Combined river and wetland site on the Kruismans River upstream of the confluence with the Krom Antonies River (upstream R366 bridge)	G30D	32°36'0.58"S; 18°41'34.83"E	Ptn 1 of Eenheid 42
EWR11 RW-G30D KROM GOERG	Combined river and wetland site on the lower Krom Antonies River upstream of confluence with Verlorenvlei	G30D	32°36'4.02"S; 18°41'28.52"E	Goergap 40 Re
EWR12 RW-G30E VERL WITTE	Combined river and wetland site immediately upstream of the estuarine functional zone	G30E	32°27'29.91"S; 18°31'2.19"E	Ptn 4 of Wittedrift 4; Ptn 6 Bonteheuwel 1 Re
EWR13 W-G30A DUNE FA277	Isolated depression/duneslack wetland	G30A	32°22'39.14"S; 18°19'48.28"E	Ptn 27 of Farm 277
EWR14 W-G30A ROSH FA272	Wetland site within Rosher Pan	G30A	32°36'49.34"S; 18°17'55.89"E	Farm 272
EWR15 RW-G30A PAPK BOOKR	Combined river and wetland site immediately upstream of the estuarine functional zone of the Jakkals River	G30A	32°37'53.62"S; 18°18'46.32"E	Ptn 1 of Bookram 30
EWR16 W-G30A PAPK RIETF	Wetland site near the source of the Papkuils River	G30A	32°38'1.26"S; 18°29'56.29"E	Ptn 3 of Rietfontein 18; Rietvlei 19 Re

Table 3: Characteristics of River and Wetland EWR sites

EWR Formal site names	Ecoregion	Geomorphological zone	Bioregion	Vegetation Type	Geology	Main land and water use	Present Ecological Status	Ecological Importance
EWR1 RW-F60A BRAK STRAN	Western Coastal Belt	Lower foothill	Namaqualand Riviere	Inland Saline Vegetation	aeolian sand and alluvium	Largely natural with some livestock	B	High; FEPA and NWM5 Mapped wetland
EWR2 W-F60A DEPR NUWEB	Western Coastal Belt	NA	Namaqualand Sand Fynbos	Northwest Fynbos	aeolian sand and alluvium	Largely natural with some livestock	Not assessed	NWM5 Mapped wetland
EWR3 RW-F60B GRGO KOMKA	Western Coastal Belt	Lower foothill	Namaqualand Riviere	Inland Saline Vegetation	granites and gneisses of the Namaqualand Metamorphic Complex	Largely natural with some dryland annual crops along river; mining downstream	B	High; NWM5 Mapped wetland
EWR4 RW-G30H SAND HOLLE	Western Coastal Belt	Upper/Lower foothill	Namaqualand Riviere; Namaqualand Strandveld	Inland Saline Vegetation; Namaqualand Sandveld	Alluvium and sand deposits and TMG sandstone	Largely natural with some dryland annual crops and fallow land along river; planted pastures; Strandfontein downstream	E	Moderate; FEPA and NWM5 Mapped wetland
EWR5 RW-G30G JAKK KOOKF	Western & South Western Coastal Belt	Upper/Lower foothill	Leipoldtville Sand Fynbos	Northwest Fynbos	aeolian sand and alluvium	Natural areas with intensive planted pastures/crops, groundwater abstraction, Lamberts Bay downstream	D	Moderate; FEPA and NWM5 Mapped wetland
EWR6 RW-G30F LANG BRAND	Western Coastal Belt	Lower foothill	Leipoldtville Sand Fynbos	Northwest Fynbos	aeolian sand and alluvium	Natural areas with intensive planted pastures/crops along river, groundwater abstraction	C	Moderate; FEPA and NWM5 Mapped wetland
EWR7 W-G30F WADR WAGEN	Western Coastal Belt	Lower foothill	Lambert's Bay Strandveld	West Strandveld	aeolian sand and alluvium	Natural areas with planted pastures/crops along river, livestock grazing, groundwater abstraction	E	FEPA and NWM5 Mapped wetland
EWR8 RW-G30D KRUI EENHE	South Western Coastal Belt	Lower foothill	Swartland Shale Renosterveld	West Coast Renosterveld	Alluvium, aeolian sand and conglomerate of the Klipheuwel Group	Natural areas with intensive planted pastures/crops along river, groundwater abstraction	D	Moderate; FEPA and NWM5 Mapped wetland
EWR9 RW-G30D KROM GOERG	South Western Coastal Belt	Upper foothill	Swartland Shale Renosterveld	West Coast Renosterveld	Alluvium, aeolian sand and conglomerate of the Klipheuwel Group	Natural areas with intensive planted pastures/crops along river, groundwater abstraction	D	Moderate; FEPA and NWM5 Mapped wetland
EWR10 RW-G30E VERL WITTE	Western & South Western Coastal Belt	Lower foothill	Leipoldtville Sand Fynbos	Northwest Fynbos	Alluvium, aeolian sand and conglomerate of the Klipheuwel Group	Natural areas with intensive planted pastures/crops along river, groundwater abstraction	D	Moderate; FEPA and NWM5 Mapped wetland

EWR11 W-G30A DUNE FA277	South Western Coastal Belt	NA	Seashore Vegetation; Langebaan Dune Strandveld	West Strandveld	Aeolian sand	Natural areas with some planted pastures/crops and groundwater abstraction upslope	Not assessed	FEPA and NWM5 Mapped wetland
EWR12 W-G30A ROSH FA272	South Western Coastal Belt	NA	Seashore Vegetation; Langebaan Dune Strandveld	West Strandveld	Aeolian sand	Natural areas with intensive planted pastures/crops and groundwater abstraction upslope	Not assessed	FEPA and NWM5 Mapped wetland
EWR13 RW-G30A PAPK BOOKR	South Western Coastal Belt	Lower foothill	West Strandveld	Saldanha Flats Strandveld	Aeolian sand	Natural areas with intensive planted crops along river, groundwater abstraction	D	Moderate; FEPA and NWM5 Mapped wetland
EWR14 W-G30A PAPK RIETF	South Western Coastal Belt	Upper foothill	Northwest Fynbos	Leipoldtville Sand Fynbos	TMG sandstone	Natural areas with planted pastures/crops along river, livestock grazing, groundwater abstraction, invasive alien trees	Not assessed	FEPA and NWM5 Mapped wetland

2. DRY SEASON ASSESSMENT OF THE RIVER AND WETLAND EWR SITES

A reconnaissance level field visit was undertaken to the study area from 16 to 18 March to inform the selection of the river and wetland EWR sites. The field survey of the estuary EWR sites is described in a separate report appended to this report.

The dry season survey of the river and wetland EWR sites was undertaken in the week of 3 April 2022. The assessment team members are listed in Table 4.

Table 4. Rivers and Wetlands Survey Team

Team member	Role
Mr. Dana Grobler	Co-ordination, support and Liaison
Ms. Toni Belcher	Co-ordination and rivers assessment
Dr. Charlie Boucher	River and wetland vegetation
Mr. Dean Ollis	Wetland assessment
Dr. Linda Rossouw	Water quality
Mr Nico Rossouw	Water quality

Mrs Shaddai Daniel from the DWS Regional Office joined the survey team for most of the week and assisted in the data collection. Mr. Julian Conrad also joined the team for part of the week and provided additional groundwater information for the assessment.

A separate field assessment is to be undertaken by Mr Dean Impson and Mr Bentley Engelbrecht to ascertain the distribution of indigenous fish for the dry season.

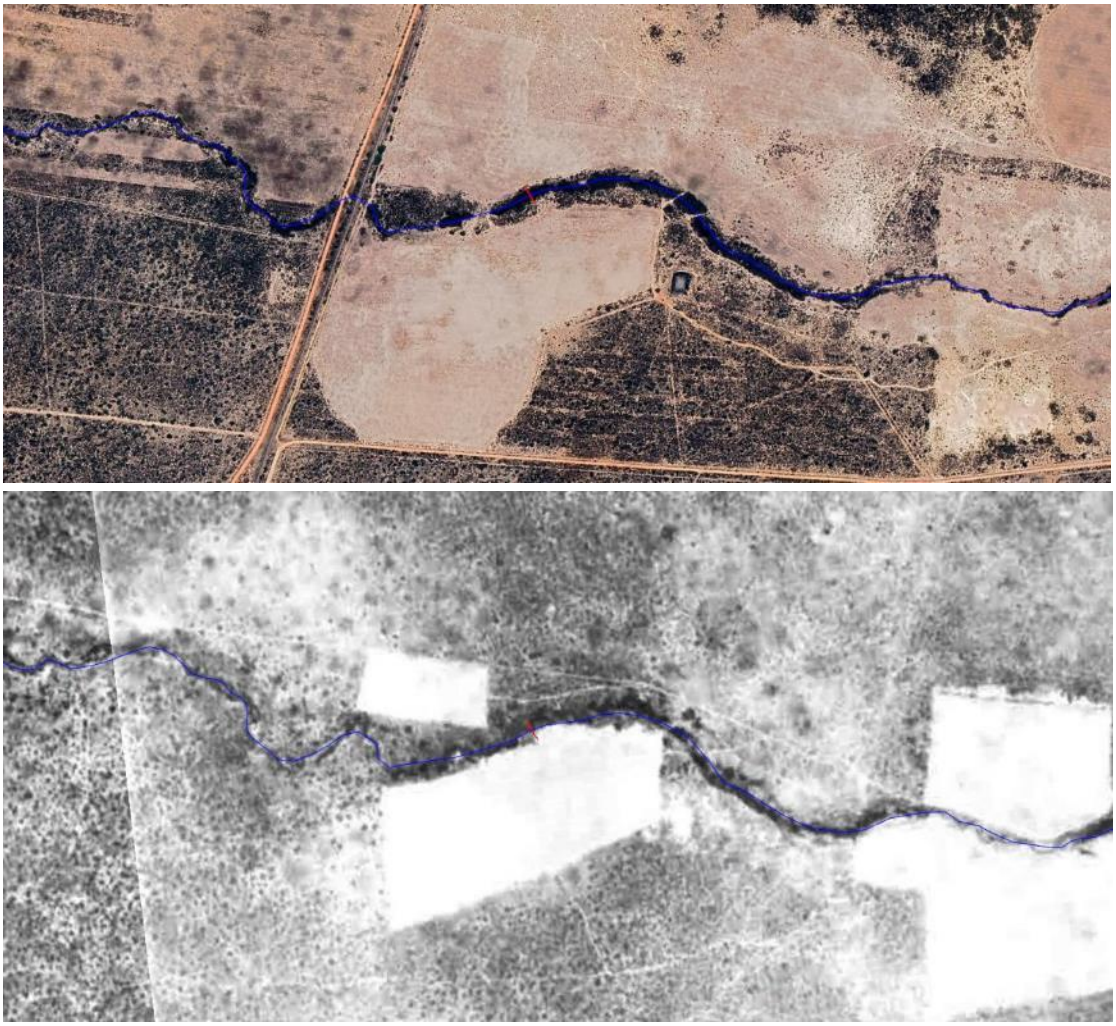
The field report from the water quality survey is attached as Appendix A.

2.1. Papkuils Catchment

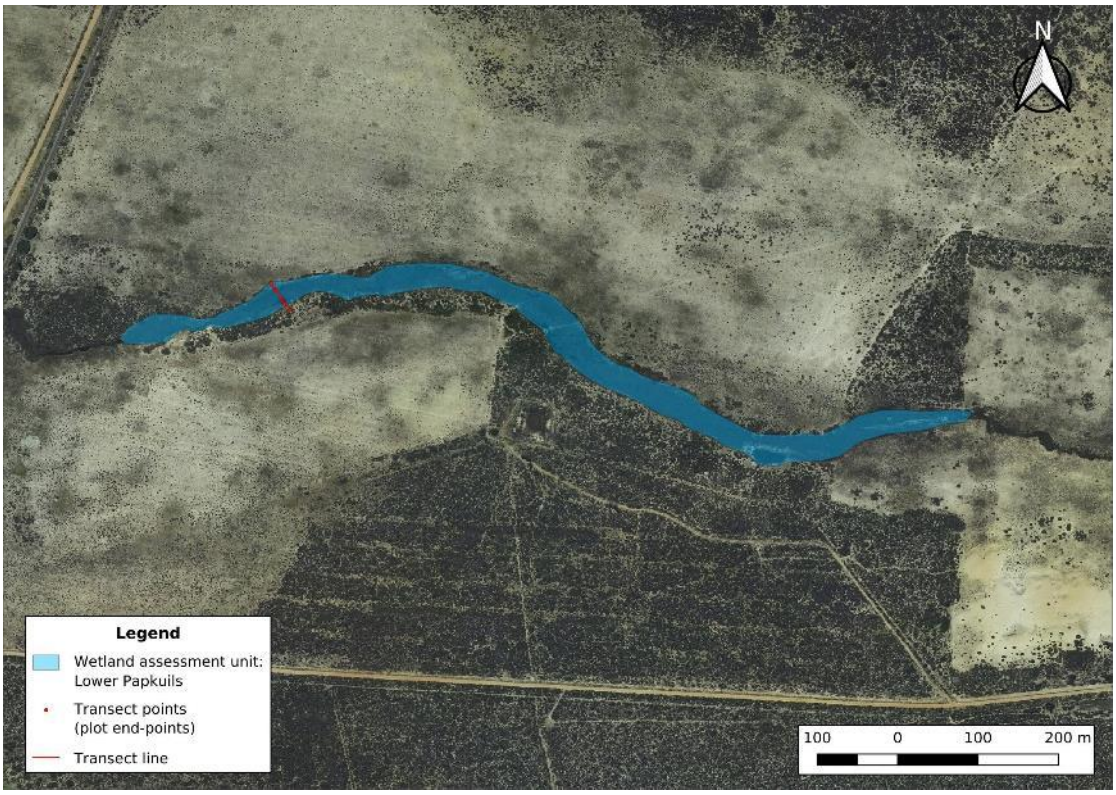
The most southern catchment, G30A is situated between Piketberg on the west and the coast. It is also largely flat, with a number of small water bodies, the most important being Rosherpan and the Papkuilsvlei that feeds the river. The river itself comprises largely a longitudinal wetland that has been significantly modified by the surrounding agricultural activities. Four sites were selected within this quaternary catchment, one on the lower Papkuils River (river/wetland EWR site), a second at Rosherpan (wetland assessment site only), a third (wetland assessment site only) at the Papkuilsvlei and a fourth (wetland assessment site only) at an isolated depression along the coast.

Lower Papkuils (EWR15 RW-G30A PAPK BOOKR)

Google Earth imagery (April 2022) and 1942 aerial photograph overlay of the site:



Mapped wetland assessment unit:



Google Earth image of the transect through the site:

View of the lower Papkuils River site:

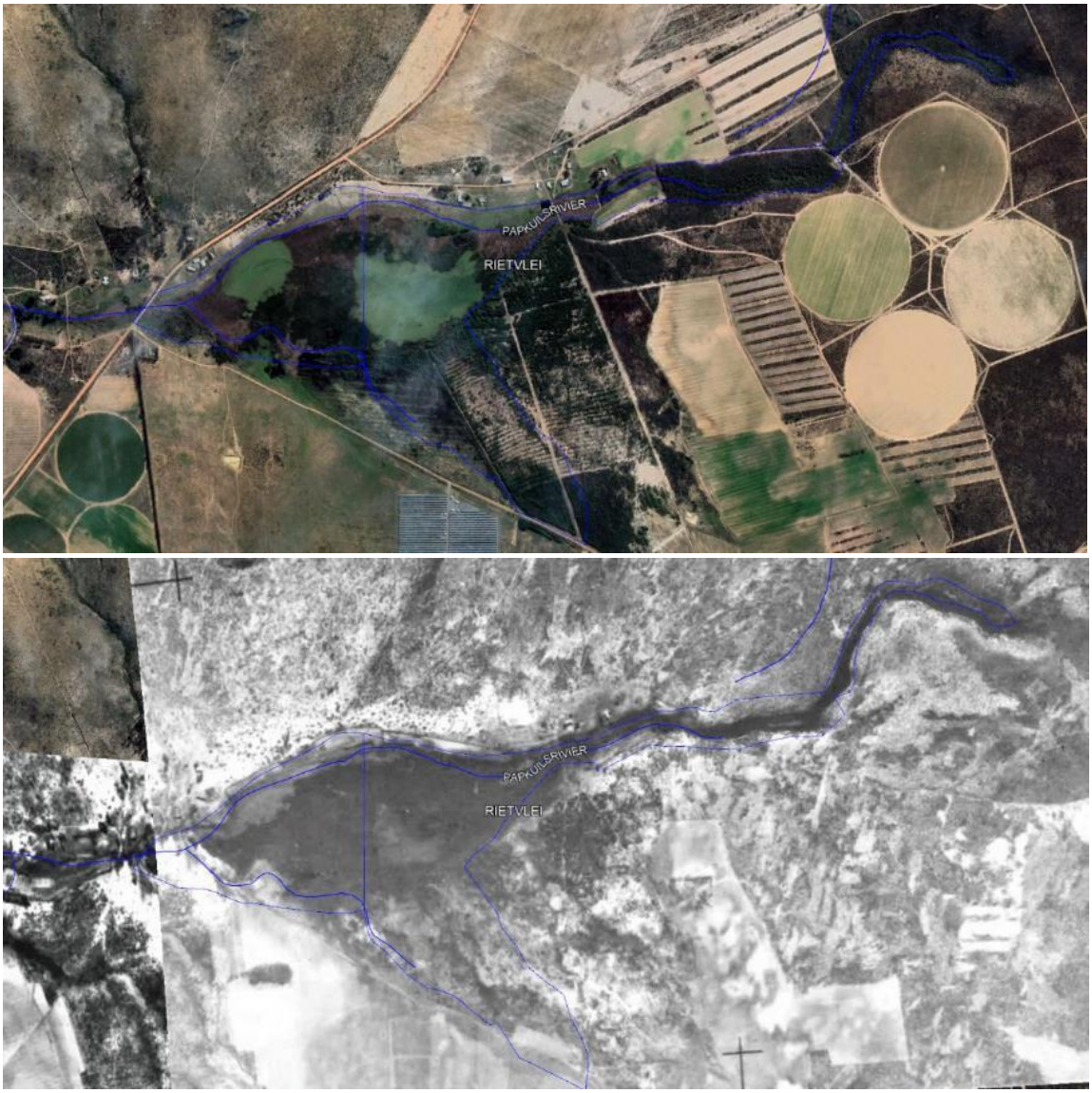
Datasheet for the site:

Table 1. Alphabetic Floristic data for LOWER PAPKUILS **Western Sandveld Wetlands**

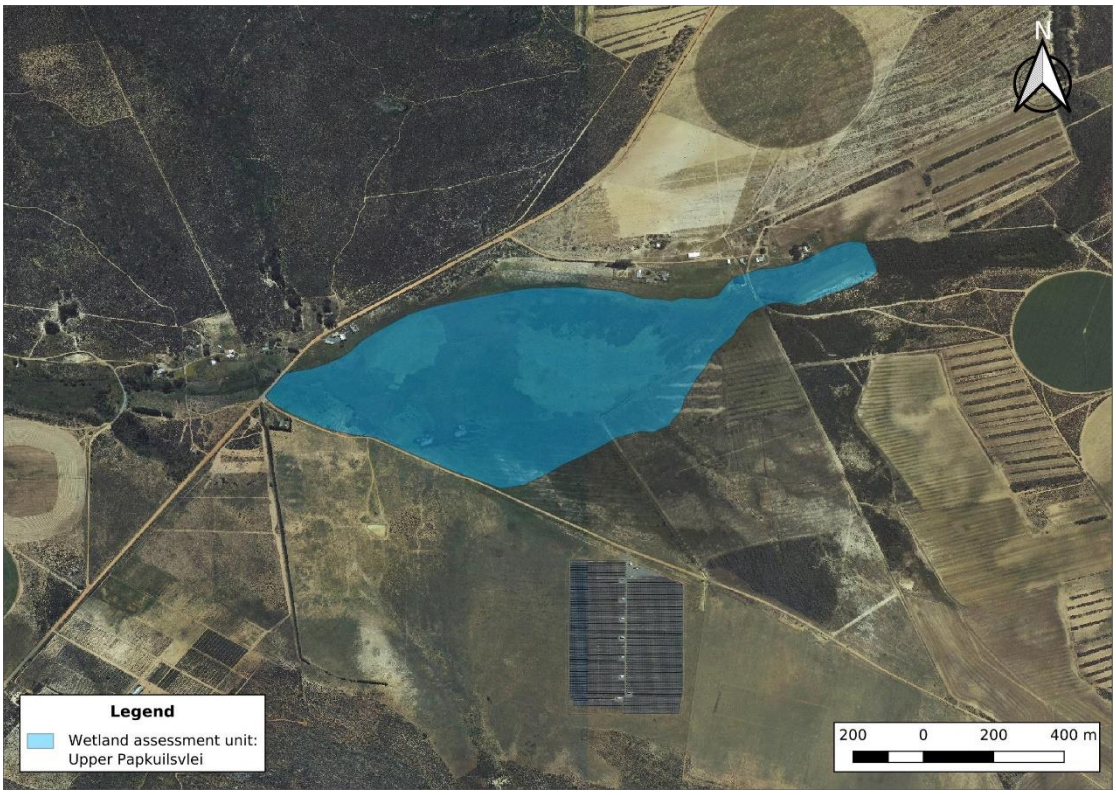
Sample no. [RP=Rosher Pan; LP=Lower Papkuils; UP = Upper Papkuils; KA=Krom-Antonies; KM=Kruismansrivier; JR=Jakkalsrivier; LV=Langvlei; VW=Verlorenvlei Wittedrif; G30A=Duneslack Wetland]	LPN4		LPN3		LPN2		LPN1		LP0		LPS1		LPS2		LPS3		LPS4		No. of sample plots =
Date	2022-04-05		2022-04-05		2022-04-05		2022-04-05		2022-04-05		2022-04-05		2022-04-05		2022-04-05		2022-04-05		**9**
Grid ref plot start peg from Low point to Outer edge (South)	32°37'51.69"S		32°37'51.94"S		32°37'52.04"S		32°37'52.38"S		32°37'52.46"S		32°37'52.53"S		32°37'52.64"S		32°37'52.66"S		32°37'52.96"S		
Grid ref plot start peg from Low point to Outer edge (East)	18°18'51.59"E		18°18'51.75"E		18°18'51.82"E		18°18'52.08"E		18°18'52.12"E		18°18'52.15"E		18°18'52.20"E		18°18'52.23"E		18°18'52.51"E		
Plot length	6.2		4.2		12.25		5.2		5.35		2.5		1.7		8.6				
Moisture status (I = inundated, free water; W = wet, M = moist, D = Dry, S = seasonal condition)	D		SD		SM		SW		SI		SW		SM		SD		D		
Habitat	Dry sandy slope outer edge		Transition Path. Bare patch.		Channel Organic Marsh		Edge pan		LP 0-1 Pan		Channel Marsh		Very narrow Transition Path		Dry sandy slope outer edge		Outer sand Strandveld		**No. of species in area =**
No. of species in sample plot	6		5		2		2		2		1		3		3		4		**14**
Taxon (* = Listed in RDB)																			**No. of occurrences**
Aspalathus spinescens Thunb.			]										<1						2
Conicosia pugioniformis (L.) N.E.Br.	<1																<1		2
Ehrharta villosa J.H.Schult.	2																10		2
Hermannia prismatocarpa E.Mey. ex Harv.			<1																1
Juncus acutus L.			10		70		98				98		1		25				6
Lycium cinereum Thunb	50		65												50				3
Nidorella foetida (L.) DC.													<1						1
Phragmites australis (Cav.) Steud.									1										1
Sarcocornia natalensis (Bunge ex Ung.-Sternb.) A.J.Scott									2										1
Searsia glauca (Thunb.) Moffett	3																10		2
Searsia laevigata (L.) F.A.Barkley	5																		1
Senecio cakilefolius DC.					20		1												2
Sporobolus virginicus (L.) Kunth			<1												2				2
Zygophyllum morgsana L	<1																<1		2

Papkuilsvlei (EWR16 W-G30A PAPK RIETF)

Google Earth imagery (April 2022) and 1942 aerial photograph overlay of the site:



Mapped wetland assessment unit:



View of the Papkuilsvlei:

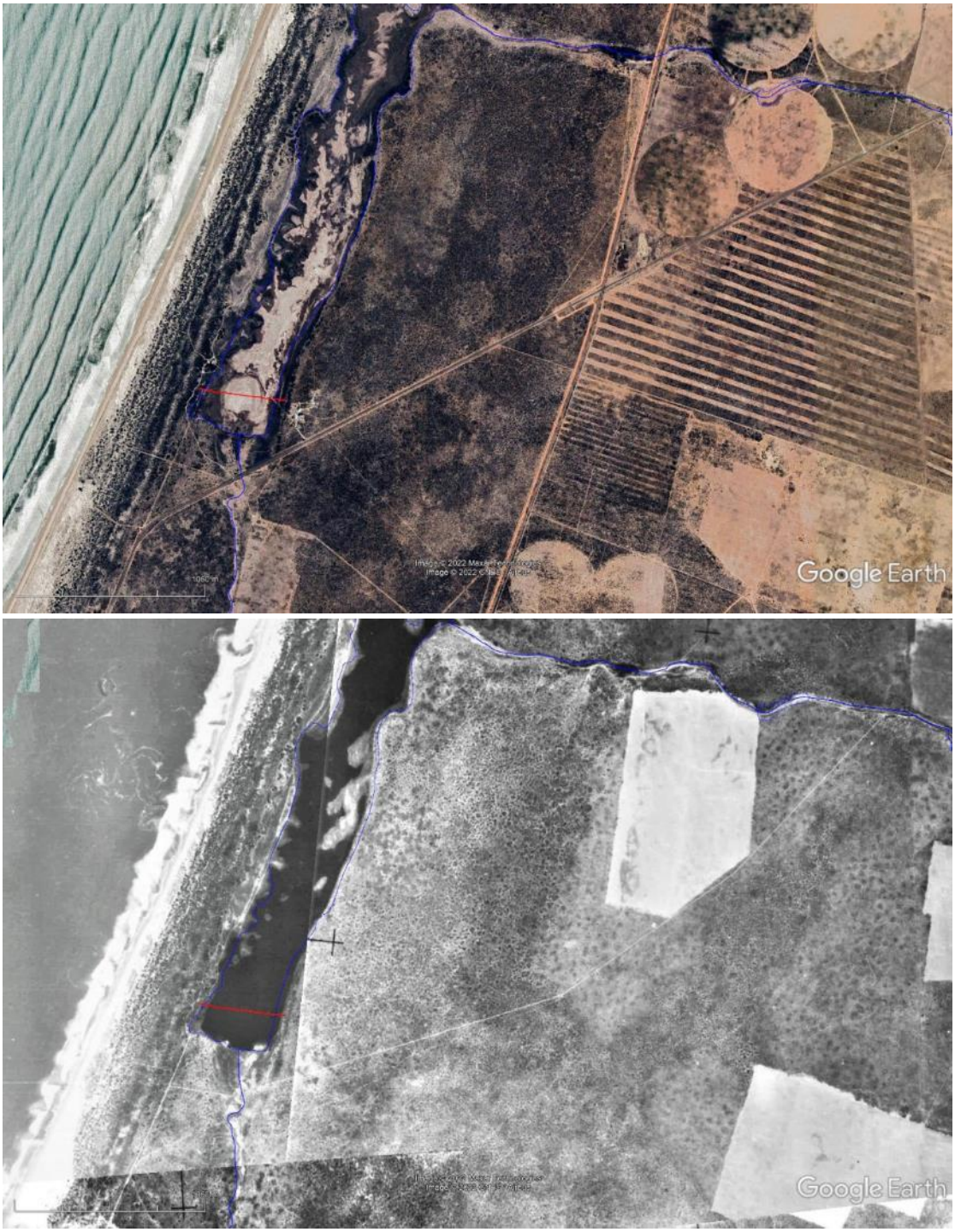
Datasheet for the site:

Table . Numerical Floristic data for UPPER PAPKUILS RIVER Western Sandveld Wetlands

Sample no. UP = Upper Papkuils	UPG1		UPG2		UPG3		UPG4		UPG5		No. of sample plots =
Date	2022-04-05		2022-04-05		2022-04-05		2022-04-05		2022-04-05		5
Grid ref plot start peg from Low point to Outer edge (South)	32°38'12.82"S		32°38'12.14"S		32°38'11.56"S		32°38'9.10"S		32°38'4.91"S		
Grid ref plot start peg from Low point to Outer edge (East)	18°29'53.29"E		18°29'53.30"E		18°29'53.57"E		18°29'53.92"E		18°29'54.90"E		
Plot length											
Moisture status (I = inundated, free water; W = wet, M = moist, D = Dry, S = seasonal condition)	SM		SW		SD		SW		SW		
Habitat	South border. Moles. Disturbed.		Excavated ditch		Moist area clay. Canals on sides		Central Flats Wetland		Sand on clay. Tall marsh near Phrag		No. of species in area =
No. of species in sample plot	8	0	4	0	3	0	5	0	16	0	26
Taxon (* = Listed in RDB)											No. of occurrences
Sporobolus virginicus (L.) Kunth	5						40				2
Cynodon dactylon (L.) Pers.	45										1
Panicum maximum Jacq.			5								1
Conicosia pugioniformis (L.) N.E.Br.	40										1
Isolepis antarctica (L.) Roem. & Schult.			3								1
Elytropappus scaber (L.f.) Druce	<1						<1		<1		3
Searsia laevigata (L.) F.A.Barkley									<1		1
Acacia cyclops A.Cunn. ex G.Don *									1		1
Pennisetum macrourum Trin.									5		1
Aspalathus sp. (Boucher UP 3-2)							5				1
Asparagus africanus Lam.	<1										1
Athanasia trifurcata (L.) L.					1						1
Berzelia abrotanoides (L.) Brongn.									1		1
Centella asiatica (L.) Urb.									<1		1
Cliffortia sp. (Boucher UP 3-9)									10		1
Elegia tectorum (L.f.) Moline & H.P.Linder									<1		1
Erica sp. (Boucher UP 3-5)									1		1
Ficinia acuminata (Nees) Nees			1								1
Ficinia lateralis (Vahl) Kunth	<1										1
Ischyrolepis sp									85		1
Juncus capensis Thunb.									1		1
Lotononis sp. (Boucher UP 3-1)					2						1
Metalasia sp. (Boucher UP 3-4)									<1		1
Monopsis lutea (L.) Urb.	<1										1
Morella serrata (Lam.) Killick									<1		1
Pennisetum clandestinum Hochst. ex Chiov. *			2								1
Pentaschistis ampla (Nees) McClean	2										1
Pseudopentameris macrantha (Schrad.) Conert									1		1
Psoralea aphylla L. (Boucher UP 3-8)									20		1
Restio (Ischyrolepis) subverticillatus (Steud.) Mast.							60				1
Schoenoplectus scirpoides (Schrad.) Browning									5		1
Stoebe nervigera (DC.) Sch.Bip.							2				1
Typha capensis (Rohrb.) N.E.Br.					10						1

Rosherpan (EWR14 W-G30A ROSH FA272)

Google Earth imagery (April 2022) and 1942 aerial photograph overlay of the site:



Mapped wetland assessment unit:

Google Earth image (April 2022) of the transect through the site:

View of the site:

Datasheet for the site:

Table 1. Alphabetic Floristic data for Rocher Pan, Western Sandveld Wetlands

RP=Rosher Pan; LP=Lower Papkuils; UP = Upper Papkuils; KA=Krom-Antonies; KM=Kruismansrivier; JR=Jakkalsrivier; LV=Langvlei; VW=Verlorenvlei Wittedrif; G30A=Duneslack Wetland	RPE1	RPE2	RPE3	RPE4	RPE5	RPE6	RPE7	RPE8	RPE9	RPW1	RPW2	RPW3	RPW4	RPW5	No. of sample plots =
Date	2022-04-04	2022-04-04	2022-04-04	2022-04-04	2022-04-04	2022-04-04	2022-04-04	2022-04-04	2022-04-04	2022-04-04	2022-04-04	2022-04-04	2022-04-04	2022-04-04	**14**
Grid ref plot start peg from Low point to Outer edge (South)	32°36'49.63"S	32°36'49.64"S	32°36'49.66"S	32°36'49.97"S	32°36'49.75"S	32°36'50.10"S	32°36'50.00"S	32°36'50.18"S	32°36'50.19"S	32°36'49.07"S	32°36'48.84"S	32°36'48.84"S	32°36'48.36"S	32°36'48.17"S	
Grid ref plot start peg from Low point to Outer edge (East)	18°17'58.26"E	18°17'59.23"E	18°17'59.77"E	18°18'0.49"E	18°18'1.03"E	18°18'2.00"E	18°18'2.75"E	18°18'3.49"E	18°18'4.73"E	18°17'52.78"E	18°17'50.94"E	18°17'50.26"E	18°17'48.27"E	18°17'46.36"E	
Plot length	63.3	25.3	14	18	17.7	9.7	20.2	19.6	30.7	99	32.75	32.7	32.7	50.95	
Moisture status (I = inundated, free water; W = wet, M = moist, D = Dry, S = seasonal condition)	SI	SW	SM	SM	SM	D	SD	D	SM	SI	SW	SM	SD	SW	
Habitat	P0-1. White & Black sand.	White sand. Hyper saline	Slope of step. Dense veg.	Dense veg flat. Small open areas	Large patches flat. hyper saline.	Termites. Large open areas.	Grazing. Path.	Large area dead veg	Upwelling Seep. Old Rd.	Saline marsh no veg	Edge pan	Pan vegetated annual inundated	Pan scrapings. Dead Phrag + shi	Old pan edge. Excavations.	**No. of species in area =**
No. of species in sample plot	0	1	3	6	7	5	5	9	10	0	3	3	7	12	0 **23**
Taxon (* = Listed in RDB)	**Percentage occurrence in sample**														**No. of occurrences**
Asparagus racemosus Willd.														<1	1
Atriplex cinerea Poir. subsp. *bolusii* (C.H.Wright) Aellen									2						1
Atriplex semibaccata R.Br.								2					60		2
Carpobrotus edulis (L.) L.Bolus													1	1	2
Drosanthemum floribundum (Haw.) Schwantes									<1						1
Ficinia nodosa (Rottb.) Goetgh., Muasya & D.A.Simpson									1					<1	2
Frankenia repens (P.J.Bergius) Fourc.				<1	5	<1									3
Juncus acutus L.								5	5						2
Juncus kraussii Hochst.									15					70	2
Lycium cinereum Thunb								<1					<1	<1	3
Mesembryanthemum crystallinum L				<1	<1			1						30	4
Nidorella foetida (L.) DC.					<1	<1	5	10	30				<1	<1	7
Phragmites australis (Cav.) Steud.												<1	<1	20	3
Prenia pallens (Aiton) N.E.Br.				1	<1										2
Salsola kali L. *														1	1
Salicornia meyeriana Moss			<1	1	1	1					<1				5
Sarcocornia natalensis (Bunge ex Ung.-Sternb.) A.J.Scott	<1	95	75	2							60	40	5		7
Sarcocornia perennis (Mill.) A.J.Scott						20	30	5	10						4
Sarcocornia pillansii (Moss) A.J.Scott							5	2	80					30	4
Senecio burchellii DC.							<1								1
Senecio halimifolius L.								D	2				<1	30	4
Sporobolus virginicus (L.) Kunth		1	<1		75	40	1		5		30	60		<1	9
Zygophyllum morgsana L								<1							1

Isolated Duneslack Wetland (EWR13 W-G30A DUNE FA277)

Google Earth image (August 2020) of the the site:

Mapped wetland assessment unit:

View of the site:

Datasheet for the site:

Table 1. Alphabetic Floristic data for G30A DUNE SLACK, Western Sandveld Wetlands

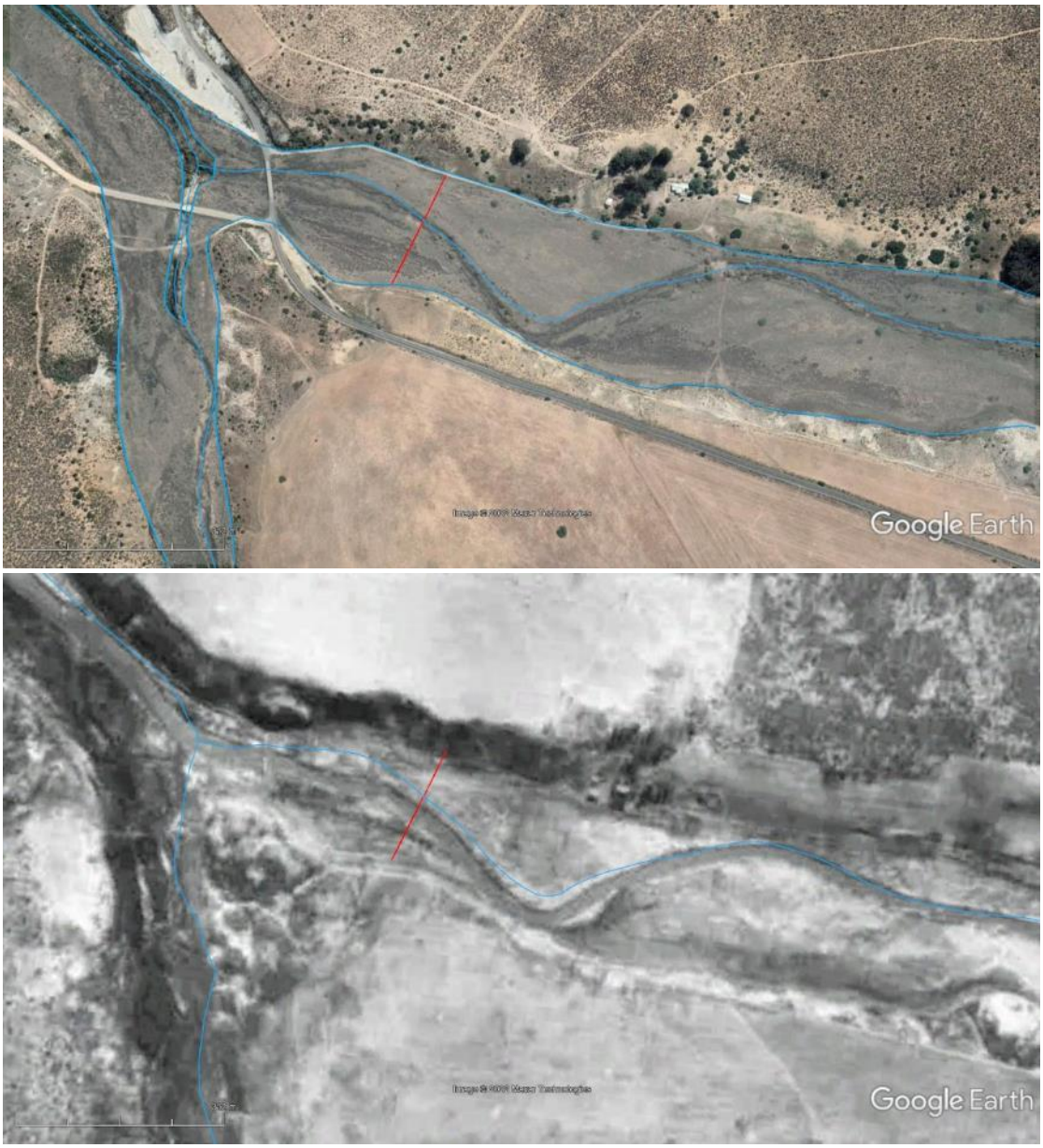
Sample no. [G30A=Duneslack Wetland]	G30A2		G30A3		G30A4		G30A5		No. of sample plots =
Date	2022-04-08		2022-04-08		2022-04-08		2022-04-08		4
Grid ref plot start peg from Low point to Outer edge (South)									
Grid ref plot start peg from Low point to Outer edge (East)									
Moisture status (I = inundated, free water; W = wet, M = moist, D = Dry, S = seasonal condition)	SI		SW		SD		D		
Photograph number									
Habitat	Dense reedbeds.		Pan fringing reedbeds		Open Lawn		Stranveld dune fringe. Molerats.		No. of species in area =
No. of species in sample plot	7		4		5		8		19
Taxon (* = Listed in RDB)									No. of occurren
Atriplex semibaccata R.Br.					5				1
Ballota africana (L.) Benth.							5		1
Cynodon dactylon (L.) Pers.			30		75		40		3
Drosanthemum floribundum (Haw.) Schwantes					<1				1
Euphorbia caput-medusae L.							<1		1
Exomis microphylla (Thunb.) Aellen var. *axyrioides* (Fenzl) Aellen					2				1
Frankenia repens (P.J.Bergius) Fourc.	2		1						2
Juncus acutus L.	15								1
Lycium cinereum Thunb	30				15				2
Osteospermum incanum Burm.f.	<1								1
Phragmites australis (Cav.) Steud.	60		10						2
Ruschia sp.							5		1
Samolus valerandi L.	1								1
Sarcocornia natalensis (Bunge ex Ung.-Sternb.) A.J.Scott	10								1
Sporobolus virginicus (L.) Kunth			60						1
Stoeberia frutescens (L.Bolus) Van Jaarsv							5		1
Trachyandra divaricata (Jacq.) Kunth							1		1
Willdenowia incurvata (Thunb.) H.P.Linder							1		1
Zygophyllum morgsana L							5		1

2.2. Verlorenvlei Catchment

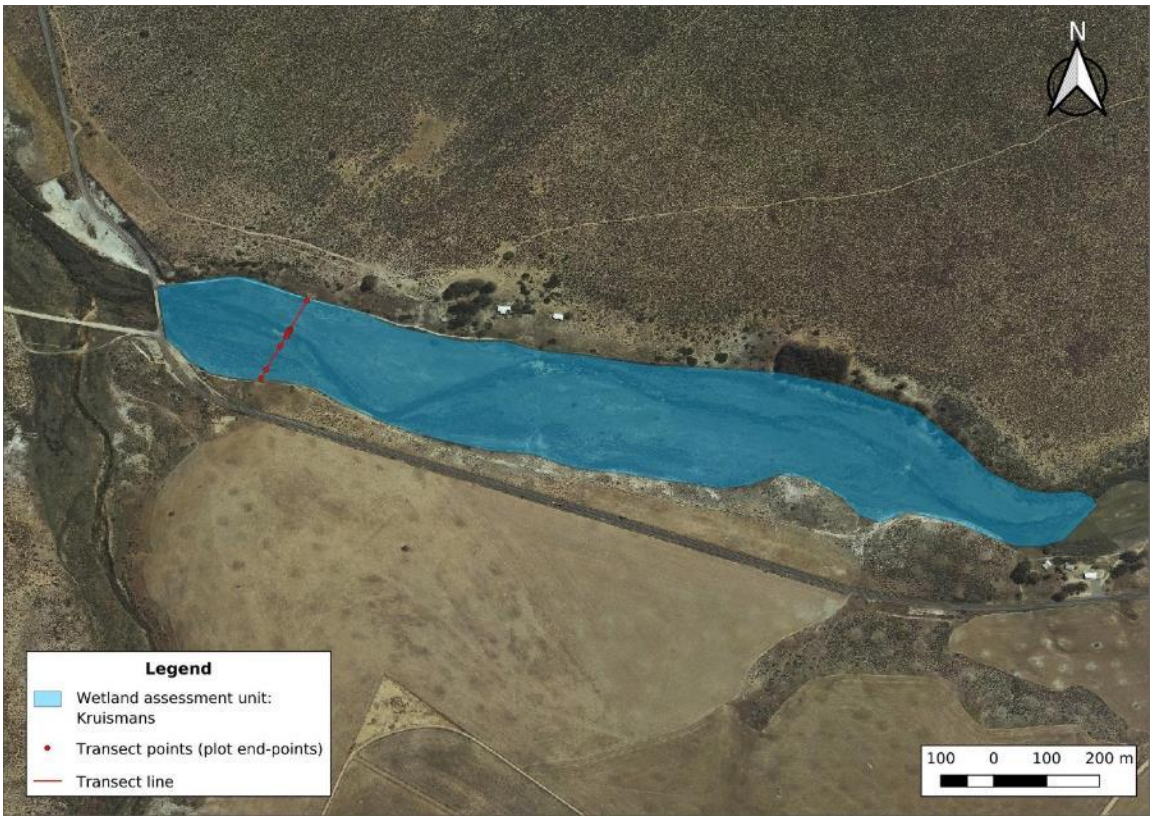
Quaternary catchments G30B (Kruismans River) and G30C (Bergvallei River) form the upper catchment of Verlorenvlei. The catchment of the Kruismans River (G30B) is basin-shaped and surrounded by high mountains, with the Piketberg Mountains to the west and the Olifantsrivierberg to the east. The Kruismans River flows to the north and west where it cuts through the Piketberg Mountains and is joined by the Bergvallei, Krom Antonies, and Hol rivers to form the Verlorenvlei River. The Verlorenvlei River flows from catchment G30D into G30E, through a well-defined catchment that is rectangular in shape with a northwest / southeast trend. Three river/wetland EWR sites are located within the Verlorenvlei Catchment, on the lower Krom Antonies and lower Kruismans Rivers as well as on the Verlorenvlei River, just upstream of the estuary.

Lower Kruismans (EWR10 RW-G30D KRUI EENHE)

Google Earth imagery (April 2022) and 1942 aerial photograph overlay of the site:

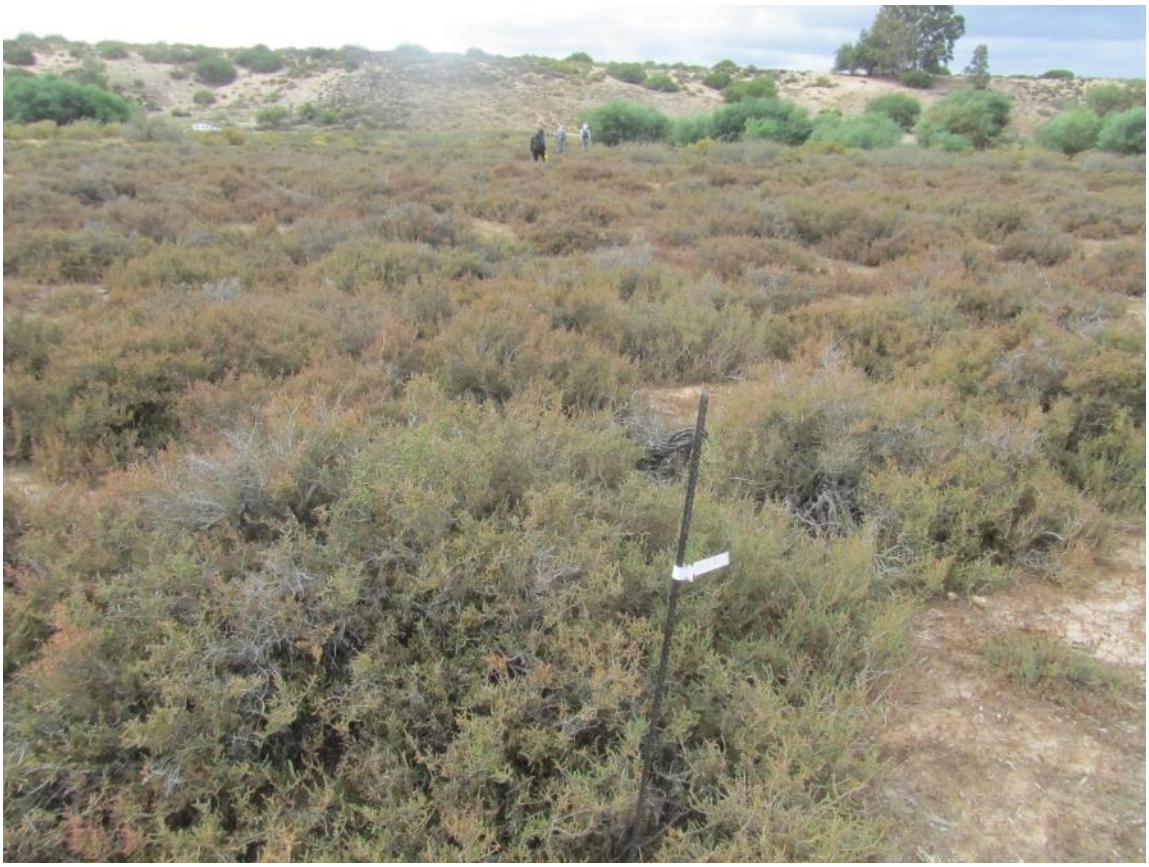


Mapped wetland assessment unit:



Google Earth image (April 2022) of the transect through the site:

Views of the site:



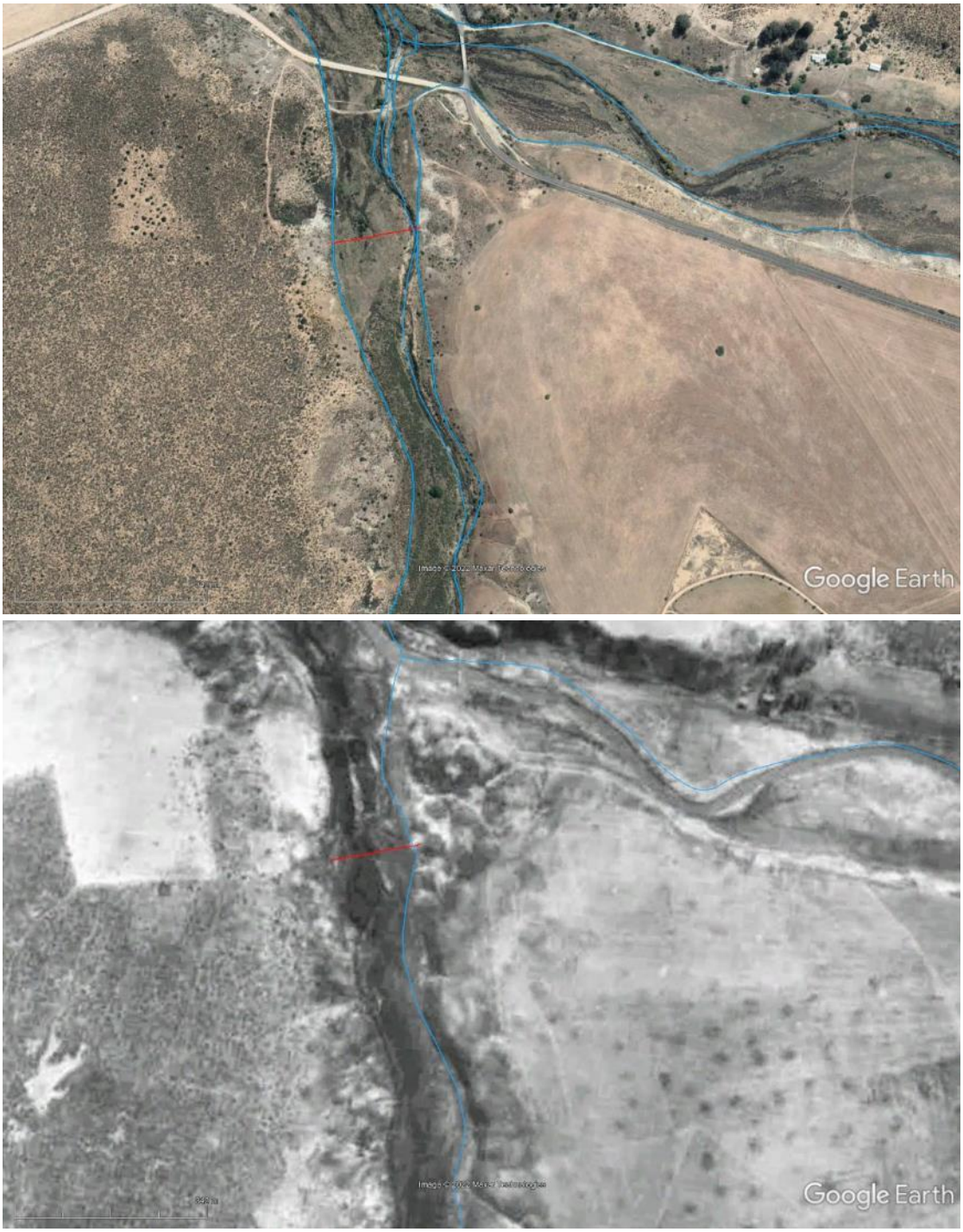
Datasheet for the site:

Table 1. Alphabetic Floristic data for KRUISMANS RIVER Western Sandveld Wetlands

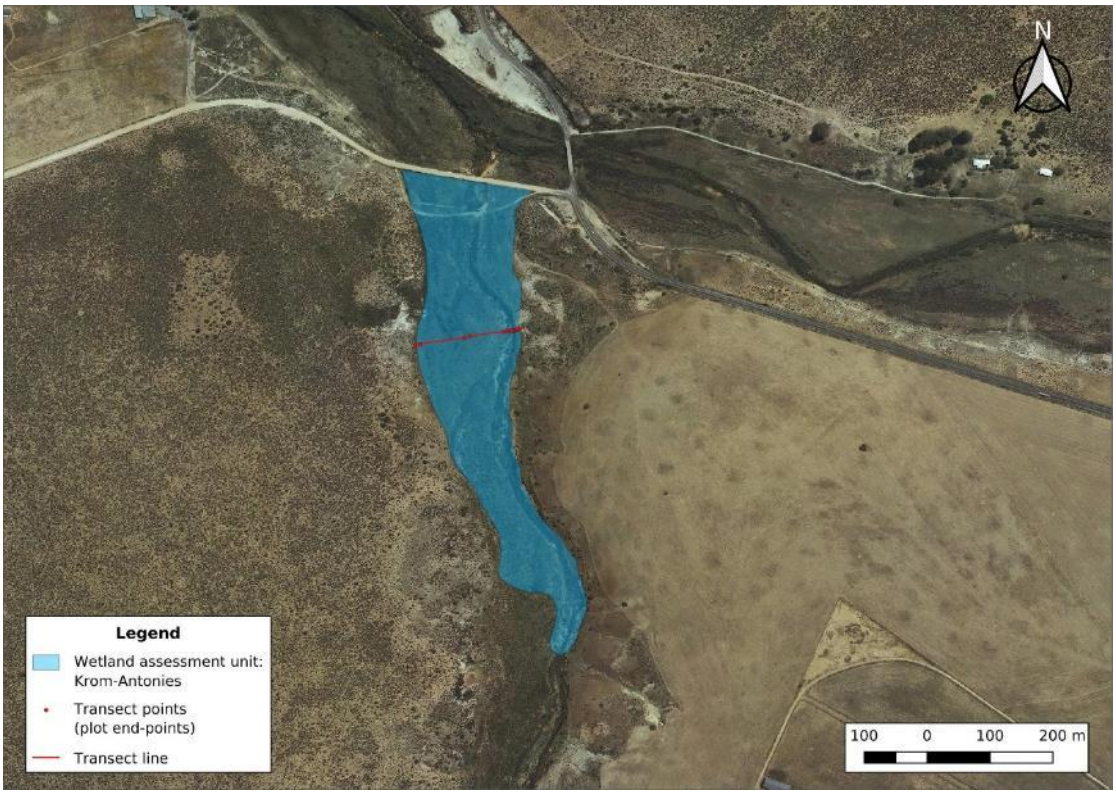
Sample no. [M=Kruismansrivier]	KMS5		KMS4		KMS3		KMS2		KMS1		KM0		KMN1		KMN2		KMN3		KMN4		No. of sample plots =
Date	2022-04-06		2022-04-06		2022-04-06		2022-04-06		2022-04-06		2022-04-06		2022-04-06		2022-04-06		2022-04-06		2022-04-06		10
Grid ref plot start peg from Low point to Outer edge (South)	32°36'05.02"S		32°36'03.29"S		32°36'02.60"S		32°36'02.38"S		32°36'02.32"S		32°36'02.27"S		32°36'02.23"S		32°36'02.11"S		32°36'02.06"S		32°35'60.00"S		
Grid ref plot start peg from Low point to Outer edge (East)	18°41'42.28"E		18°41'43.31"E		18°41'43.71"E		18°41'43.82"E		18°41'43.89"E		18°41'43.91"E		18°41'43.96"E		18°41'44.04"E		18°41'44.04"E		18°41'45.25"E		
Plot length	19.7		58.5		23.5		7.13		2.85		2.07		4.55		4.55		2.2		70.1		
Moisture status (I = inundated, free water; W = wet, M = moist, D = Dry, S = seasonal condition)	SD		SM		SM		SW		SW		SI		SW		SM		SD		SM		
Photograph number																					
Habitat	High flood old course flats.		Saline mud. Old channel. Grazing.		Flood shelf. Trampling. Moles.		Sandy. Trampled. Sloping bank		Side of channel		Channel. Cattle crossing.		Wetbank. Channel edge.		Annual Flood bank		Floodplain. Moles. Stock grazing.		Back channel on floodplain edge.		No. of species in area =
No. of species in sample plot	5		8		7		5		3		2		5		2		7		7		22
Taxon (* = Listed in RDB)																					No. of occurren
Acacia saligna (Labill.) H.L.Wendl. *							15						15								2
Atriplex lindleyi Moq. *			<1																		1
Atriplex semibaccata R.Br.	5				<1												2		25		4
Berkheya herbacea (L.f.) Druce					<1																1
Cynodon dactylon (L.) Pers.	2				80		10								80		50		70		6
Cyperus textilis Thunb.									60				50								2
Exomis microphylla (Thunb.) Aellen var. *axyrioides* (Fenzl) A	5				10												15				3
Ficinia nodosa (Rottb.) Goetgh., Muasya & D.A.Simpson	1																				1
Frankenia repens (P.J.Bergius) Fourc.			<1		<1												<1		1		4
Galenia africana L.	20				15												<1				3
Hordeum capense Thunb.																			<1		1
Juncus acutus L.							70												5		2
Juncus kraussii Hochst.			1										15								2
Melianthus major L.																			5		1
Ornithogalum sp.					1																1
Panicum maximum Jacq.							1														1
Phragmites australis (Cav.) Steud.			1				10		20		60		25		1						6
Prenia pallens (Aiton) N.E.Br.			2																		1
Prosopis glandulosa Torr.																			2		1
Sarcocornia natalensis (Bunge ex Ung.-Sternb.) A.J.Scott			1						10		5		5				<1				5
Sarcocornia pillansii (Moss) A.J.Scott			85														10				2
Sporobolus virginicus (L.) Kunth			1																		1

Lower Krom Antonies (EWR11 RW-G30D KROM GOERG)

Google Earth imagery (April 2022) and 1942 aerial photograph overlay of the site:



Mapped wetland assessment unit:



Google Earth image (April 2022) of the transect through the site:

Views of the site:

Datasheet for the site:

Table X. Alphabetic Floristic data for **KROM-ANTONIES RIVER** Western Sandveld Wetlands

Sample no. [KA=Krom-Antonies]	KAE3		KAE2		KAE1		KA0		KAW1		KAW2		KAW3		KAW4		KAW5		KAW6		KAW7		KAW7b		KAW8		No. of sample plots =
Date	2022-04-06		2022-04-06		2022-04-06		2022-04-06		2022-04-06		2022-04-06		2022-04-06		2022-04-06		2022-04-06		2022-04-06		2022-04-06		2022-04-06		2022-04-06		13
Grid ref plot start peg from Low point to Outer edge (South)	32°36'10.70"S		32°36'10.76"S		32°36'10.82"S		32°36'10.81"S		32°36'10.80"S		32°36'10.82"S		32°36'10.84"S		32°36'10.85"S		32°36'10.89"S		32°36'11.15"S		32°36'11.28"S		32°36'11.29"S		32°36'11.67"S		
Grid ref plot start peg from Low point to Outer edge (East)	18°41'31.39"E		18°41'31.19"E		18°41'31.04"E		18°41'31.01"E		18°41'30.99"E		18°41'30.96"E		18°41'30.85"E		18°41'30.60"E		18°41'30.42"E		18°41'28.39"E		18°41'28.02"E		18°41'27.16"E		18°41'25.31"E		
Plot length	6.65		2.6		1.1		0.05		2.25		2.7		5.45		5.7		54.6		8.95		71.1				9.85		
Moisture status (I = inundated, free water; W = wet, M = moist, D = Dry, S = seasonal condition)	SD		SM		SW		SI		SW		SM		SD		SD		D		SM		SM		SM		SD		
Photograph number																											
Habitat	Edge Silcrete Renosterveld		Grazed. Open sand (40%)		Channel side		Channel bottom		Channel side		Grazed. Slightly raised section		Flood channel. Open sand (30%)		High flow terrace step. Grazed.		Mosaic. Undulating sand-loam flats		Shallow channel on flats		Mosaic. Undulating sand-loam flats		Clump of trees on floodplain		Highest floods. Transition Silcrete		No. of species in area =
No. of species in sample plot	3		5		4		2		2		4		3		6		5		7		10		7		2	0	28
Taxon (* = Listed in RDB)																											No. of occurrenc
Acacia saligna (Labill.) H.L.Wendl. *			5		5						5		1		<1												5
Aizoaceae sp. (Boucher KA 1-2)																	<1				1						2
Atriplex semibaccata R.Br.																	30						5				2
Cynodon dactylon (L.) Pers.			30								1		50		2		15		60		65				60		8
Cyperus textilis Thunb.					20				80						1				20								4
Dodonaea viscosa Jacq.	5																										1
Drosanthemum floribundum (Haw.) Schwantes	2																										1
Exomis microphylla (Thunb.) Aellen var. *axyrioides*	1																25		<1		2						4
Ficus domestic variety																							5				1
Frankenia repens (P.J.Bergius) Fourc.																					<1						1
Galenia africana L.			2														25								25		3
Gazania rigida (Burm.f.) Roessler																					1						1
Juncus acutus L.			10								1				3				10		4						5
Juncus kraussii Hochst.			20																		30						2
Nicotiana glauca Graham																							4				1
Nidorella ivifolia (L.) J.C.Manning & Goldblatt																					1						1
Panicum maximum Jacq.															2												1
Paspalum urvillei Steud.							5																				1
Paspalum vaginatum Sw.							5		15		80		10		75												5
Pennisetum macrourum Trin.					60																						1
Phragmites australis (Cav.) Steud.					5														<1								2
Pulicaria scabra (Thunb.) Druce																					<1						1
Rumex crispus L. *																			<1								1
Searsia laevigata (L.) F.A.Barkley																							5				1
Searsia pendulina (Jacq.) Moffett																							10				1
Searsia undulata (Jacq.) T.S.Yi, A.J.Mill. & J.Wen																							60				1
Senecio burchellii DC.																			1		<1						2
Vachellia karroo (Hayne) Banfi & Gallaso																							2				1

Macroinvertebrate Sampling:

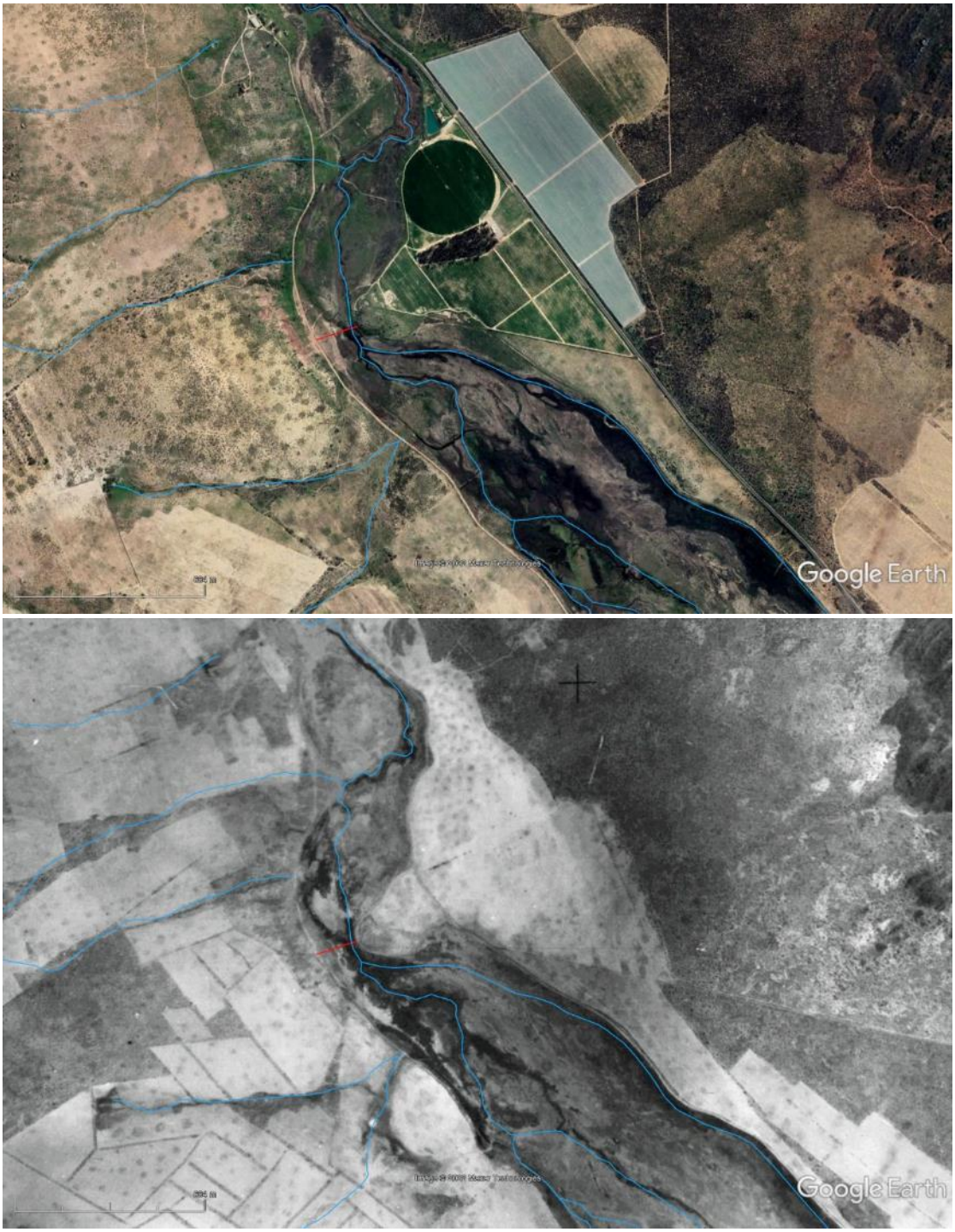
Sampling of macroinvertebrates was possible in the pools within the river using SASS5 sampling techniques. Eighteen taxa were identified in the samples taken. These are listed below with abundances indicated in the brackets:

Hydracarina (A), *Beatidae 2 sp (B), Coenagrionidae* (A), *Aeshnidae* (A), *Corduliidae, (B) Gomphidae (1), Libellulidae (B), Corixidae (B), Gerridae (B), Nedipae* (A), *Notonectidae* (A), *Pleidae* (A), *Veliidae, Dytiscidae* (A), *Chironomidae* (A), *Culicidae* (A), *Simulidae* (A) *and Lymnaeidae (B)*

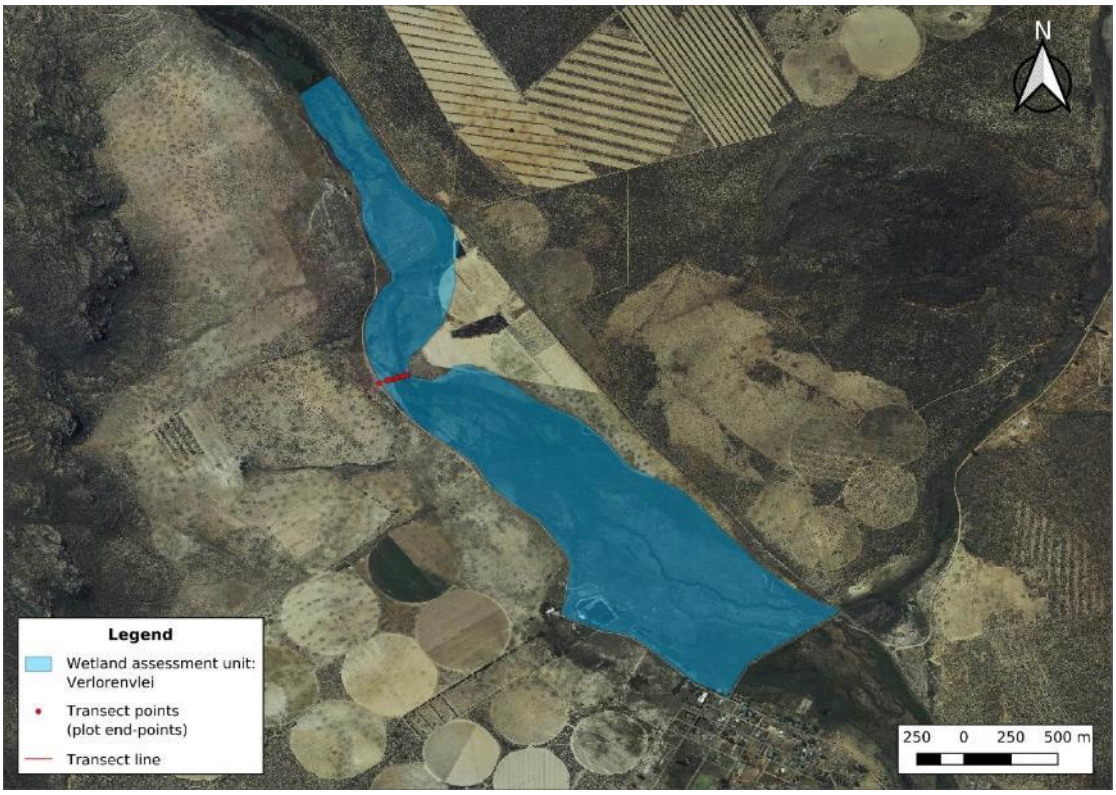
Using the SASS5 assessment method, the SASS5 score would have been 83 and the Average Score Per Taxon 4.6.

Lower Verlorenvlei (EWR12 RW-G30E VERL WITTE)

Google Earth imagery (August 2020) and 1942 aerial photograph overlay of the site:



Mapped wetland assessment unit:



Google Earth image (August 2020) of the transect through the site:

Views of the site:

Datasheet for the site:

Table 1. Alphabetic Floristic data for VERLORENVLEI - WITTEDRIF, Western Sandveld Wetlands

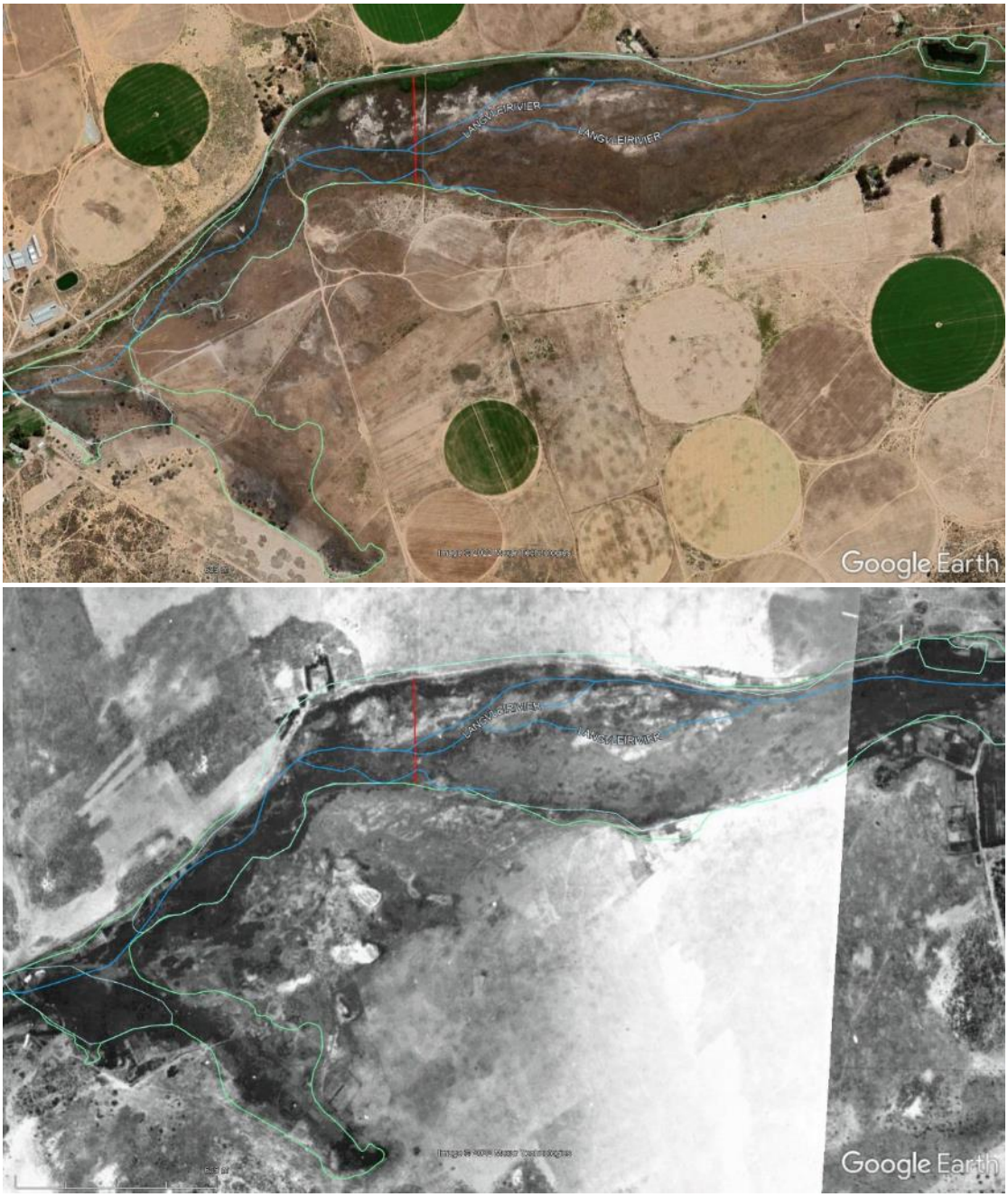
Sample no. [VW=Verlorenvlei Wittedrif]	VWN5		VWN4		VWN3		VWN2		VWN1		VW0		VWS1		VWS2		VWS3		VWS4		VWS5		VWS6		VWS7		VWS8		No. of sample plots =
Date	2022-04-08		2022-04-08		2022-04-08		2022-04-08		2022-04-08		2022-04-08		2022-04-08		2022-04-08		2022-04-08		2022-04-08		2022-04-08		2022-04-08		2022-04-08		2022-04-08		14
Grid ref plot start peg from Low point to Outer edge (South)	32°27'29.87"S		32°27'29.95"S		32°27'30.01"S		32°27'30.16"S		32°27'30.23"S		32°27'30.29"S		32°27'30.35"S		32°27'30.42"S		32°27'30.53"S		32°27'30.69"S		32°27'30.79"S		32°27'30.86"S		32°27'30.88"S		32°27'31.05"S		
Grid ref plot start peg from Low point to Outer edge (East)	18°31'4.98"E		18°31'4.79"E		18°31'4.48"E		18°31'3.94"E		18°31'3.54"E		18°31'3.37"E		18°31'3.15"E		18°31'2.90"E		18°31'2.59"E		18°31'2.13"E		18°31'1.70"E		18°31'1.48"E		18°31'1.33"E		18°31'0.75"E		
Plot length	0.93		4.37		7.77		15.35		9.1		10.2		7.88		7.45		14.3		10.35		6.5		4.35		17.05		44.1		
Moisture status (I = inundated, free water; W = wet, M = moist, D = Dry, S = seasonal condition)	SD		SM		SW		SM		SW		SI		SW		SW		SM		SD		SM		SM		SD		D		
Photograph number																													
Habitat	Slope step. Path. Grazed.		Steep cut bank. Grazed.		Side channel. Grazed. Trampled.		Channel with Artificially raised ar		Bed often flooded. Heavy grazing		Bed often flooded. Heavy grazing		Bed often flooded. Heavy grazing		Channel side		Flattish regular overflow step		Raised area. Added bed material		Slight dip at higher overflow leve		Channel side		Upper flood flats		Back floodplain.		No. of species in area =
No. of species in sample plot	4		4		5		4		2		1		3		4		3		3		5		3		5		5		17
Taxon (* = Listed in RDB)																													No. of occurren
Atriplex semibaccata R.Br.	5		1												5								2		1				5
Bolboschoenus maritimus (L.) Palla			20		30								15		15		15				20								6
Cotula coronopifolia L.					5		1														<1								3
Cyperus textilis Thunb.			60		50		30		15				75		15		25		20		65								9
Drosanthemum floribundum (Haw.) Schwantes																											1		1
Exomis microphylla (Thunb.) Aellen var. *axyrioides* (Fenzl)	1																												1
Frankenia repens (P.J.Bergius) Fourc.																			1				5		1				3
Hordeum capense Thunb.															5										<1		1		3
Isolepis antarctica (L.) Roem. & Schult.					5																<1								2
Paspalum distichum L.							10		30		10																		3
Pentaschistis densifolia (Nees) Stapf	5																												1
Phragmites australis (Cav.) Steud.					5		15										40												3
Rumex crispus L. *			<1																										1
Sarcocornia natalensis (Bunge ex Ung.-Sternb.) A.J.Scott													1																1
Sarcocornia pillansii (Moss) A.J.Scott																			40				5		60		60		4
Senecio burchellii DC.																											2		1
Sporobolus virginicus (L.) Kunth	20																				1				2		<1		4

2.3. Langvlei Catchment

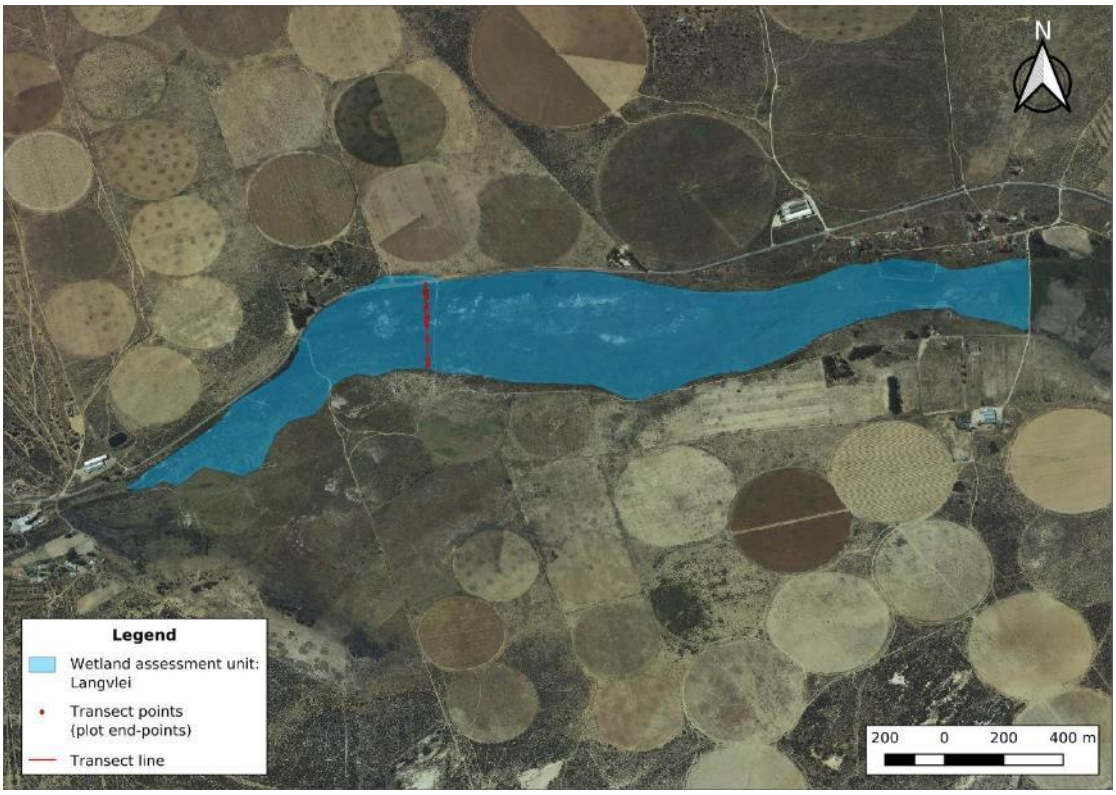
To the north of the Verlorenvlei catchment (G30E) is the Langvlei catchment (G30F), which is the largest in the area and extends from the Swartberg (1153 mamsl) in the east to the coast. The Alexandershoek and Lambertshoek Rivers drain these mountains and join to form the Langvlei River. In the lower Langvlei, extensive wetland areas occur up until the Wadrif area. Downstream from the Wadrif wetland, is the Wadrif saltpan which extends down to the coastal dune system. Two EWR sites are located in this catchment, one in the lower Langvlei (river/wetland EWR site) and a second in the Wadrif Wetland (wetland assessment site only).

Lower Langvlei (EWR8 RW-G30F LANG BRAND)

Google Earth imagery (April 2022) and 1942 aerial photograph overlay of the site:



Mapped wetland assessment unit:



Google Earth image of the transect through the site:

Views of the site:

Datasheet for the site:

Table 1. Alphabetic Floristic data for LANGVLEI Western Sandveld Wetlands

Sample no. [LV=Langvlei]	LVS10		LVS9		LVS8		LVS7		LVS6		LVS5		LVS4		LVS3		LVS2		LVS1		LV0		LVN1		No. of sample plots =
Date	2022-04-07		2022-04-07		2022-04-07		2022-04-07		2022-04-07		2022-04-07		2022-04-07		2022-04-07		2022-04-07		2022-04-07		2022-04-07		2022-04-07		12
Grid ref plot start peg from Low point to Outer edge (South)	32°12'10.41"S		32°12'7.77"S		32°12'5.80"S		32°12'5.21"S		32°12'4.74"S		32°12'3.84"S		32°12'3.37"S		32°12'2.42"S		32°12'2.01"S		32°12'1.77"S		32°12'1.58"S		32°12'1.43"S		
Grid ref plot start peg from Low point to Outer edge (East)	18°23'52.55"E		18°23'52.52"E		18°23'52.42"E		18°23'52.45"E		18°23'52.45"E		18°23'52.38"E		18°23'52.39"E		18°23'52.37"E		18°23'52.33"E		18°23'52.32"E		18°23'52.31"E		18°23'52.32"E		
Plot length	24.45		81.5		60.1		18.5		12.85		27.9		15.3		28.9		13.85		5.65		12.5		21.5		
Moisture status (I = inundated, free water; W = wet, M = moist, D = Dry, S = seasonal condition)	D		D		D		D		D		SD		SD		SM		SM		SW		SI		SW		
Photograph number																									
Habitat	Moribund. Over-grazed		Grazed sloping edge flats		Grazed flats		Saline flats		Saline flats		Undulating patchy. Hyper saline		Undulating patchy. Hyper saline		Mixed. Undulating patchy. Mud.		Mixed. Undulating. Patchy free wate		Undulating patchy free water.Grazed		Free water. Braided undulating marsh		Undulating. Free water. Dense veg.		No. of species in area =
No. of species in sample plot	6		8		4		2		4		3		2		7		8		6		5		5		23
Taxon (* = Listed in RDB)																									No. of occurre
Aizoon sarmentosum L.f.									<1																1
Atriplex cinerea Poir. subsp. *bolusii* (C.H.Wright) Aellen																			<1						1
Atriplex semibaccata R.Br.	20		4		2																				3
Cotula coronopifolia L.																					1		1		2
Dischisma ciliatum (P.J.Bergius) Choisy			10		25																				2
Drosanthemum floribundum (Haw.) Schwantes	30		<1																						2
Exomis microphylla (Thunb.) Aellen var. *axyrioides* (Fer	2		1																						2
Frankenia repens (P.J.Bergius) Fourc.					1		10				1		4		2		2		<1						7
Hordeum capense Thunb.															5										1
Isolepis antarctica (L.) Roem. & Schult.																	4								1
Isolepis hystrix (Thunb.) Nees																							5		1
Juncus acutus L.															1				5		95				3
Juncus kraussii Hochst.																	6				2				2
Lycium cinereum Thunb	2																								1
Manochlamys albicans (Aiton) Aellen			<1																						1
Mesembryanthemum crystallinum L	1		5																						2
Panicum maximum Jacq.									15						20		1								3
Phragmites australis (Cav.) Steud.																	1		30		1		95		4
Psilocaulon coriarium (Burch. ex N.E.Br.) N.E.Br.			<1																						1
Salicornia meyeriana Moss									2		2				5		5								4
Sarcocornia natalensis (Bunge ex Ung.-Sternb.) A.J.Scott															50		5		5		3		2		5
Sarcocornia pillansii (Moss) A.J.Scott	2		60		50		40		75		50		90		20		75		15						10
Sporobolus virginicus (L.) Kunth																							2		1

Macroinvertebrate Sampling:

Sampling of macroinvertebrates was possible in the shallow water and pool within the river using SASS5 sampling techniques. Ten taxa were identified in the samples taken. These are listed below with abundances indicated in the brackets:

Hydracarina (B), *Beatidae 2 sp (B), Coenagrionidae* (A), *Gomphidae (1), Corixidae (B), Notonectidae* (A), *Dytiscidae* (A), *Chironomidae* (A), *Culicidae* (B), *and Muscidae (A)*

Using the SASS5 assessment method, the SASS5 score would have been 39 and the Average Score Per Taxon 3.9. The water was saline (20 260 mg/l TDS), the substrate anoxic mud and algae abundant in the vegetation.

Wadrif Wetland (EWR9 W-G30F WADR WAGEN)

Google Earth imagery (April 2022) and 1942 aerial photograph overlay of the site:

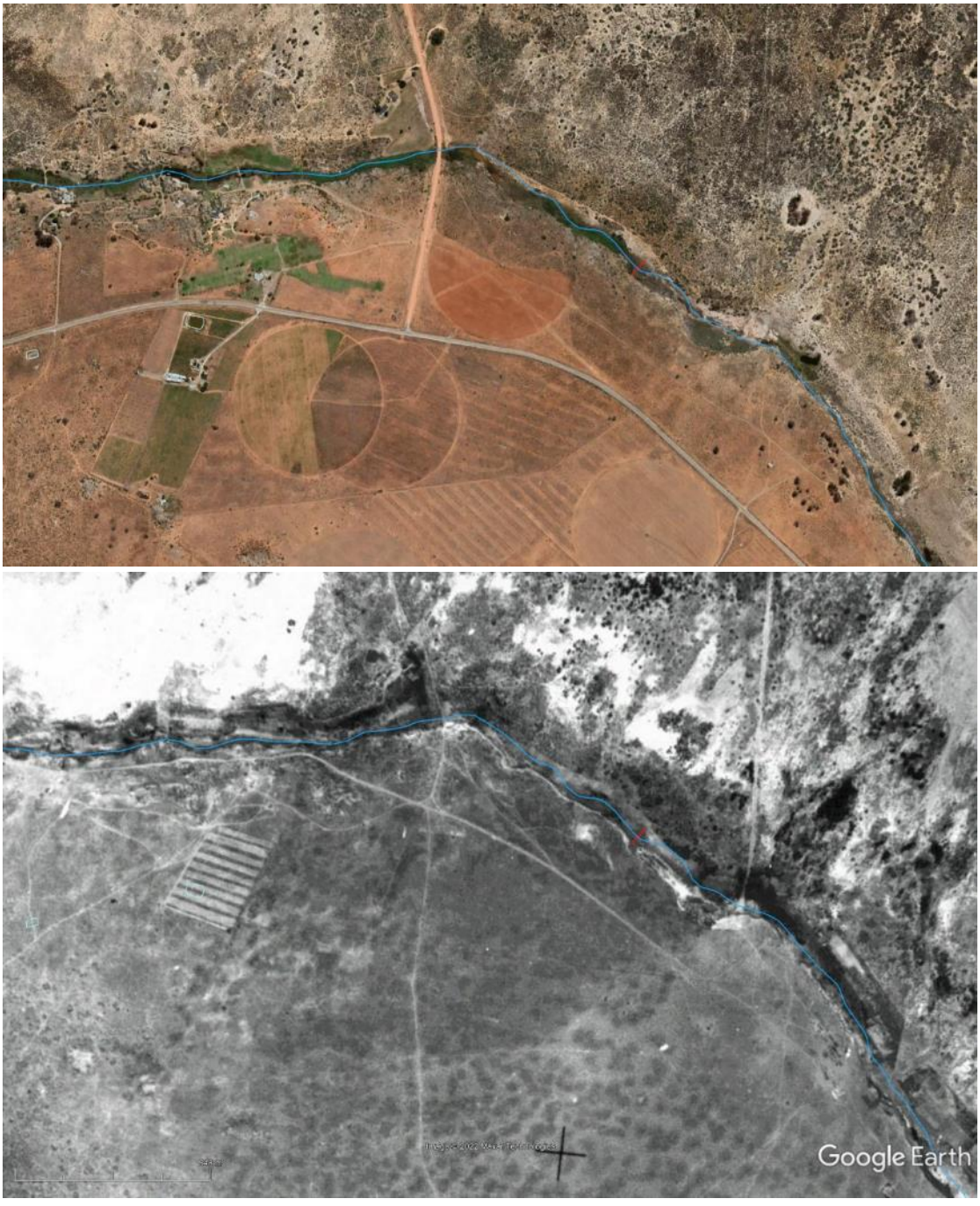
View of the site:

2.4. Jakkals Catchment

To the north of the Langvlei/Wadrif catchment is the Jakkals catchment (G30G). It is bounded in the east by the rugged Langeberg and Uitkomsberge mountains that drop off quite rapidly to the west. The town of Graafwater is at the base of these mountains. From Graafwater to the coast, the topography is relatively flat and featureless. At the coast, the Jakkals River terminates with the Jakkalsvlei. A single river/wetland EWR is located in the lower reaches of this system.

Lower Jakkals (EWR7 RW-G30G JAKK KOOKF)

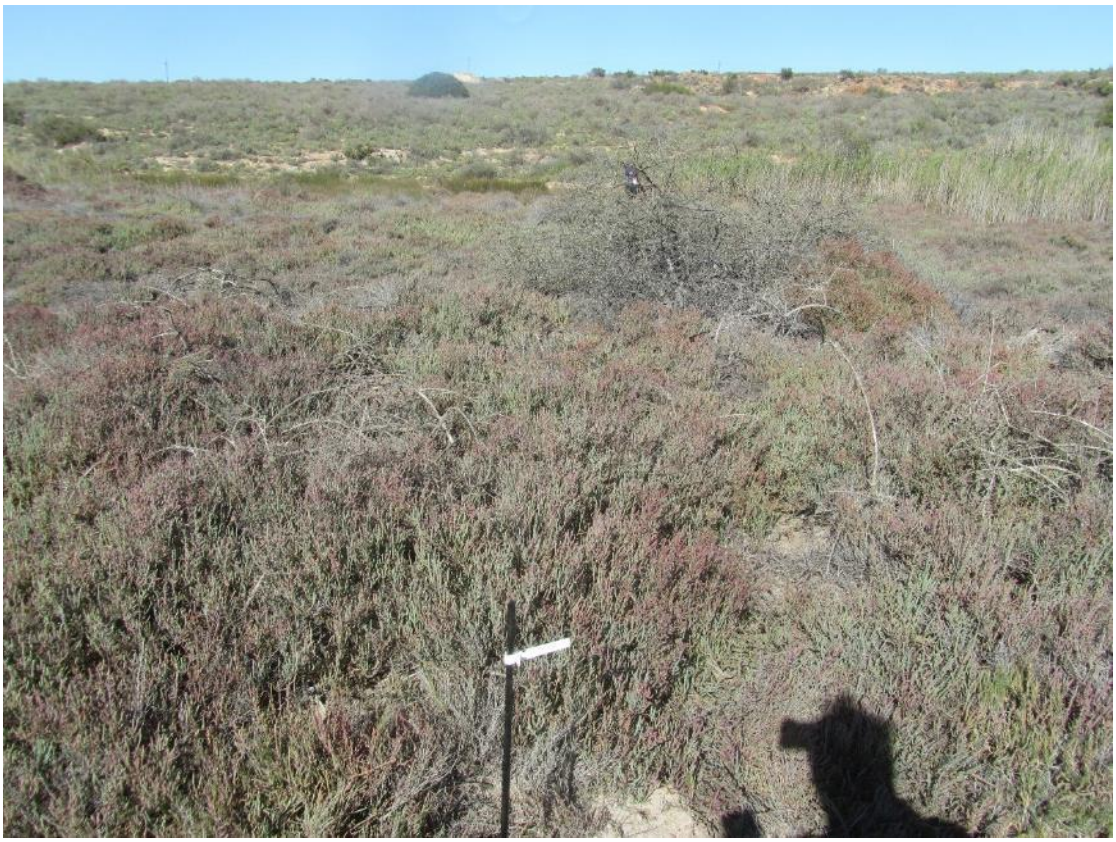
Google Earth imagery (April 2022) and 1942 aerial photograph overlay of the site:



Mapped wetland assessment unit:

Google Earth image of the transect through the site:

Views of the site:



Datasheet for the site:

Table 1. Alphabetic Floristic data for **JAKKALS RIVER** Western Sandveld Wetlands

Sample no. [JR=Jakkalsrivier]	JRS3		JRS2		JRS1		JR0		JRN1		JRN2		JRN3		JRN4		JRN5		No. of sample plots =
Date	2022-04-07		2022-04-07		2022-04-07		2022-04-07		2022-04-07		2022-04-07		2022-04-07		2022-04-07		2022-04-07		9
Grid ref plot start peg from Low point to Outer edge (South)	32° 5'10.59"S		32° 5'10.54"S		32° 5'10.53"S		32° 5'10.51"S		32° 5'10.49"S		32° 5'10.49"S		32° 5'09.81"S		32° 5'09.58"S		32° 5'09.39"S		
Grid ref plot start peg from Low point to Outer edge (East)	18°22'40.19"E		18°22'40.31"E		18°22'40.33"E		18°22'40.32"E		18°22'40.32"E		18°22'40.30"E		18°22'41.11"E		18°22'41.34"E		18°22'41.55"E		
Plot length	1.37		2.9		1.17		0.74		0.83		28.5		9.4		8.48		6.48		
Moisture status (I = inundated, free water; W = wet, M = moist, D = Dry, S = seasonal condition)	SD		SM		SW		SI		SW		SM		SM		SD		D		
Photograph number																			
Habitat	High flood level		Sloping side shelf		Channel side		Channel floor. Lightly grazed.		Channel side		Annually flooded slight slope side		Flood plain		Bare sand patches - Moles		Top of high flood flows. Moles		No. of species in area =
No. of species in sample plot	5		4		3		3		3		4		2		5		11		19
Taxon (* = Listed in RDB)																			No. of occurre
Acacia cyclops A.Cunn. ex G.Don *																	2		1
Carpobrotus edulis (L.) L.Bolus																	5		1
Conicosia pugioniformis (L.) N.E.Br.																	<1		1
Didelta carnosa (L.f.) Aiton var. *carnosa*	5																		1
Exomis microphylla (Thunb.) Aellen var. *axyrioides* (Fenzl) A	10																5		2
Felicia tenella (L.) Nees																	1		1
Frankenia repens (P.J.Bergius) Fourc.			14												10				2
Hermannia prismatocarpa E.Mey. ex Harv.																	<1		1
Isolepis hystrix (Thunb.) Nees															10		20		2
Juncus acutus L.											2								1
Lycium cinereum Thunb	15												10						2
Mesembryanthemum crystallinum L																	1		1
Nidorella foetida (L.) DC.															1				1
Panicum maximum Jacq.																	40		1
Phragmites australis (Cav.) Steud.			1		5		40		25		5								5
Sarcocornia natalensis (Bunge ex Ung.-Sternb.) A.J.Scott					50		40		10		45								4
Sarcocornia pillansii (Moss) A.J.Scott	10		40								45		80		40				5
Sporobolus virginicus (L.) Kunth	<1		60		45		20		60						35		15		7
Zygophyllum morgsana L																	1		1

Macroinvertebrate Sampling:

Sampling of macroinvertebrates was possible in the shallow water within the river channel using SASS5 sampling techniques. Three taxa were identified in the sample taken. These are listed below with abundances indicated in the brackets:

Corixidae (B), Hydrophilidae (A), and *Culicidae* (A)

Using the SASS5 assessment method, the SASS5 score would have been 9 and the Average Score Per Taxon 3. The water was saline (14 443 mg/l TDS), the substrate anoxic mud and algae abundant in the vegetation.

2.5. Sandlaagte catchment

The most northern catchment of the study area G30H consists of the coastal plain south of the Olifants River mouth. There are no significant surface water bodies within this catchment and land use development is limited. A single EWR site has been selected in the lower Sandlaagte River that is still to be assessed.

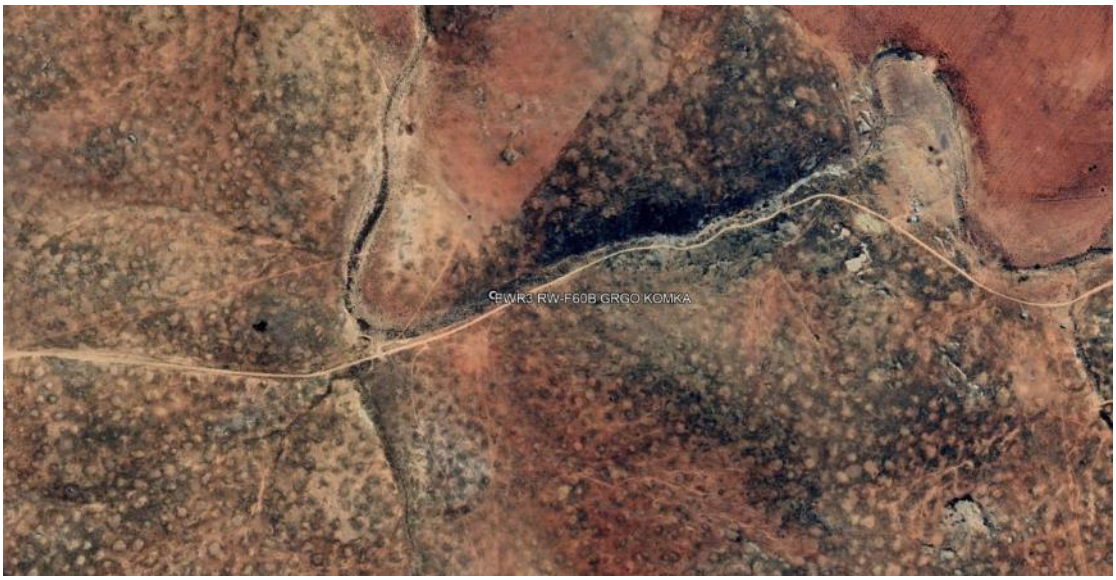
Google Earth image of the site:

View of the site:

2.6. Sout Catchment

To the north of the Olifants River Estuary is the Sout River Catchment that comprises the Groot Goerap (F60D), Klein Goerap (F60B) and the Sout River F60C). The rivers drain westwards from the high-lying hills along the N7, draining down to the deep sands on the coast. Due to the arid nature of this area, the surface water features are largely ephemeral and land use activities are limited. A single EWR site was selected within this catchment, on the lower Groot Goerap River. Three additional wetland assessment sites were also selected of depressions within the Northwest Fynbos, Knersvlakte and Sandveld Bioregions. These sites are still to be assessed.

Google Earth image of the site:



View of the site:

2.7. Brak Catchment

The Brak River is a small catchment (F60A) in the northern portion of F60. Like the Sout River to the south, the river drains the higher-lying Ribbokberg, draining westwards through the deep sands on the coast. The surface water features are ephemeral, with limited land use that comprises largely of livestock. significant surface water bodies within this catchment and land use development are limited. A single river/wetland EWR site has been selected in the lower river that is still to be assessed.

Google Earth image of the site:

View of the site:

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Appendix A: Water Quality Survey Report: 3 - 4 April 2022

Appendix B: Estuaries November 2021 site survey report