Riverine Baseline Study & Risk Assessment for the proposed Pella Bulk Water Pipeline Project

Pella, Northern Cape, South Africa

January 2020

CLIENT

Prepared for:

SLR Consulting (South Africa) (Pty) Ltd

Prepared by:

The Biodiversity Company

Cell: +27 81 319 1225

Fax: +27 86 527 1965

info@thebiodiversitycompany.com

www.thebiodiversitycompany

Report Name	**Riverine Baseline Study & Risk Assessment for the proposed Pella Bulk Water Pipeline Project**
Submitted to	SLR
Report Writer (Aquatics)	Michael Ryan (Cand. Sci. Nat. 125128) Michael Ryan is an Aquatic Ecologst and Hydrologist with 2 years of experience in baseline river assessments and aquatics and is SASS5 accredited. Michael Ryan received his B.Sc Honours degree (Geography) from the University of Witwatersrand.
Report Reviewer	Dale Kindler (Pr. Sci. Nat. 114743) Dale Kindler is Pr. Sci. Nat. registered (114743) in the Aquatic Science field of practice and is an experienced aquatic ecologist. He has over 5 years of experience conducting aquatic assessments across southern Africa, Guinea and Mozambique..
Declaration	The Biodiversity Company and its associates operate as independent consultants under the auspice of the South African Council for Natural Scientific Professions. We declare that we have no affiliation with or vested financial interests in the proponent, other than for work performed under the Ecological Assessment Regulations, 2017. We have no conflicting interests in the undertaking of this activity and have no interests in secondary developments resulting from the authorisation of this project. We have no vested interest in the project, other than to provide a professional service within the constraints of the project (timing, time and budget) based on the principals of science.

The horseshoe reservoir at the end of the project area (January 2020)

Executive Summary

Specialist Opinion
It is the opinion of the specialist that provided the prescribed mitigation measures are implemented for all project related activities, the Pella pipeline project can commence as no fatal flaws were identified and the project qualifies for authorisation under the provisions of the General Authorisation.

The Biodiversity Company was commissioned by SLR Consulting (South Africa) (Pty) Ltd to conduct a riverine baseline study and impact (risk) assessment as part of the Environmental Impact Assessment (EIA), environmental authorisation process and Water Use Licence Application (WULA) for an underground pipeline that forms part of the Pella Water Supply Scheme in the Northern Cape, South Africa. Standard methodologies were applied at a single high flow survey conducted in January 2020

Baseline Environment

All rivers assessed at points where the proposed pipeline will cross a watercourse are ephemeral in nature and as a result could not be analysed. A downstream site for the project was assessed on the Orange River (O1). The results of the Present Ecological State (PES) assessment derived largely natural (class B) conditions in the Orange River reach considered in this assessment.

Habitat Integrity Assessments identified minimal habitat modification within the Orange River which indicates a largely natural state (class B). Sources of modification to the system are agriculture, regional water abstraction as part of transfer schemes as well as alien invasive plant species. *In situ* water quality for the Orange River indicates natural conditions as they conform with Target Water Quality Ranges (TWQR) with only water temperature being noncompliant but considered natural for the system. The South African Scoring System (SASS5) assessment results generated SASS scores that are categorised as a class A for the Orange River reach. The presence and wide distribution of specialist taxa across the biotopes along with high diversity of species indicates the current health of the system from a geomorphological, biological and chemical stance.

Two red listed fish species are expected within the river reaches in the study area. The Near Threatened species *Labeobarbus kimberleyensis* and the Vulnerable species is *Oreochromis mossambicus*. Both species were sampled in the Orange with the Fish Response Assessment Index (FRAI) derived scoring a moderately modified class D.

Risk Assessment

A variety of risks have been identified for the proposed project for both the construction and operational phases. The impacts of which all stem from construction within a defined watercourse. The associated risks are, however, significantly lowered due to the ephemeral nature of the watercourses but are not absent as the watercourse still forms important habitat for aquatic life when it does flow.

Taking into consideration that the project is for water reticulation, with a pipeline generally aligned in road reserves, the risks posed to watercourses are considered negligible. This is supported by the fact that the proposed pipeline will also replace existing structures, indicating the area to already be disturbed. This statement is however only considered valid provided the attributed mitigation measures are considered and implemented.

DOCUMENT GUIDE

The table below provides the NEMA (2014) Requirements for Ecological Assessments, and the relevant sections in the reports where these requirements are addressed:

GNR 326	Description	Section in the Report
Specialist Report		
Appendix 6 (a)	A specialist report prepared in terms of these Regulations must contain— details of— i. the specialist who prepared the report; and ii. the expertise of that specialist to compile a specialist report including a curriculum vitae;	Page i
Appendix 6 (b)	A declaration that the specialist is independent in a form as may be specified by the competent authority;	Page vii
Appendix 6 (c)	An indication of the scope of, and the purpose for which, the report was prepared;	Section 1
Appendix 6 (cA)	An indication of the quality and age of base data used for the specialist report;	Section 6
Appendix 6 (cB)	A description of existing impacts on the site, cumulative impacts of the proposed development and levels of acceptable change;	Section 6
Appendix 6 (d)	The duration, date and season of the site investigation and the relevance of the season to the outcome of the assessment;	Section 6
Appendix 6 (e)	A description of the methodology adopted in preparing the report or carrying out the specialised process inclusive of equipment and modelling used;	Section 3
Appendix 6 (f)	Details of an assessment of the specific identified sensitivity of the site related to the proposed activity or activities and its associated structures and infrastructure, inclusive of a, site plan identifying site alternatives;	Section 7
Appendix 6 (g)	An identification of any areas to be avoided, including buffers;	Section 7
Appendix 6 (h)	A map superimposing the activity including the associated structures and infrastructure on the environmental sensitivities of the site including areas to be avoided, including buffers;	Not applicable
Appendix 6 (i)	A description of any assumptions made and any uncertainties or gaps in knowledge;	Section 4
Appendix 6 (j)	A description of the findings and potential implications of such findings on the impact of the proposed activity **[including identified alternatives on the environment]** or activities;	Section 6
Appendix 6 (k)	Any mitigation measures for inclusion in the EMPr;	Section 7
Appendix 6 (l)	Any conditions for inclusion in the environmental authorisation;	Section 7

Appendix 6 (m)	Any monitoring requirements for inclusion in the EMPr or environmental authorisation;	Section 7
Appendix 6 (n)	A reasoned opinion— i. **[as to]** whether the proposed activity, activities or portions thereof should be authorised; (iA) regarding the acceptability of the proposed activity or activities; and ii. if the opinion is that the proposed activity, activities or portions thereof should be authorised, any avoidance, management and mitigation measures that should be included in the EMPr, and where applicable, the closure plan;	Section 8
Appendix 6 (o)	A description of any consultation process that was undertaken during the course of preparing the specialist report;	Not applicable
Appendix 6 (p)	A summary and copies of any comments received during any consultation process and where applicable all responses thereto; and	Not applicable
Appendix 6 (q)	Any other information requested by the competent authority.	None

Table of Contents

Tables

Figures

Table of Abbreviations

Abbreviations	Abbreviated Word
ASPT	Average Score Per Taxa
BAR	Basic Assessment Report
C	Consequences
DHSWS	Department of Human Settlement, Water and Sanitation
DO	Dissolved Oxygen
DWS	Department of Water and Sanitation
D	Duration
E	Extent
EAP	Environmental Assessment Practitioner
EC	Electrical Conductivity
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
EMPr	Environmental Management Program
FRAI	Fish Response Assessment Index
GA	General Authorization
I	Intensity
IHIA	Intermediate Habitat Integrity Assessment
LC	Least Concern
NEMA	National Environmental Management Act
NFEPA	National Freshwater Ecosystem Priority Areas
NT	Near Threatened
NWA	National Water Act
PES	Present Ecological State
P	Probability
S	Significance
SASS5	South African Scoring System 5
SQR	Sub Quaternary Reach
TWQR	Target Water Quality Ranges
VU	Vulnerable
WMA	Water Management Area
WULA	Water Use License Application

Declaration

I, Michael Ryan declare that:

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the Act.

Michael Ryan

Aquatic Specialist

The Biodiversity Company

January 2020

Declaration

I, Dale Kindler declare that:

- I act as the independent specialist in this application;
- I will perform the work relating to the application in an objective manner, even if this results in views and findings that are not favourable to the applicant;
- I declare that there are no circumstances that may compromise my objectivity in performing such work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, regulations and any guidelines that have relevance to the proposed activity;
- I will comply with the Act, regulations and all other applicable legislation;
- I have no, and will not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the competent authority; and the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- All the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the Act.

Dale Kindler

Aquatic Specialist

The Biodiversity Company

January 2020

1 Introduction

The modification of land use within a river catchment has the potential to degrade local water resources (Wepener *et al.,* 2005). Infrastructure thus has the potential to negatively impact on local water resources and ecosystem services. In order to holistically manage water resources in South Africa, the use of standard water quality sampling methods is considered in-effective. Non-point and point source pollutants are dynamic and can fluctuate according to several factors such as rainfall, industrial discharges and extensive pollutant seepage. Aquatic ecology is permanently exposed to the dynamic conditions within water bodies and can therefore be an effective reflection of the environmental conditions within a management area. Considering this, the monitoring of aquatic ecology is regarded as an effective tool in water management strategies. This can therefore be used to assess the current state of a system.

The Biodiversity Company was commissioned by SLR Consulting (South Africa) (Pty) Ltd to conduct a riverine baseline study and impact (risk) assessment as part of the Environmental Impact Assessment (EIA), environmental authorisation process and Water Use Licence Application (WULA) for an underground pipeline that forms part of the Pella Water Supply Scheme in the Northern Cape, South Africa.

The new underground bulk water pipeline will replace the old underground bulk water pipeline and will supply water to the proposed Gamsberg Smelter Project and existing Gamsberg Mine, Black Mountain Mine and the surrounding towns (Aggeneys, Pella, Pofadder and local landowners). The proposed pipeline will be located within the existing servitude, with water sourced from the Orange River through an intake pump house located at Pella Drift, almost 30 km to the North East of the Gamsberg Zinc Mine.

The aquatics survey was conducted on the 15th and 17th of January 2020 which constitutes a dry season survey. The assessment included defining the extent of the project area and baseline conditions of the systems. Furthermore, the identification and description of any sensitive receptors were recorded across the project area where the pipeline crossed any river system as well as a downstream site in order to monitor the effects of the project as a whole.

The project was completed in accordance with the requirements of the Water Use Authorisation in terms of Section 21(c) and (i) of the National Water Act (Act 36 of 1998) (NWA). This assessment is in accordance with the 2014 EIA Regulations (No. R. 982-985, Department of Environmental Affairs, 4 December 2014) emanating from Chapter 5 of the National Environmental Management Act (Act No. 107 of 1998). The findings and information herein are in terms of Appendix 6 of the 2014 NEMA EIA Regulations (amended in 2017).

This report, after taking into consideration the findings and recommendations provided by the specialist herein, should inform and guide the Environmental Assessment Practitioner (EAP), enabling informed decision making as to the ecological viability of the proposed development and to provide an opinion on whether any environmental authorisation process or licensing is required for the proposed activities.

1.1 Scope/Objectives

The aim of the assessment is to provide the water resource baseline and impact assessment for the proposed pipeline project. This was achieved through the following:

- Determining the PES of the local watercourses:
  - The assessment of water quality;
  - The assessment of habitat quality;
  - The assessment of biological responses;
- A risk assessment for the proposed pipeline; and
- The prescription of mitigation measures and recommendations for identified risks.

2 Project Area

The project area begins at the abstraction tower in the Orange River and Pella Drift Water Treatment Plant, 39km North West of the town of Aggeneys (Northern Cape) and runs South East till ending at the Horseshoe Reservoir. The remaining stretch of the bulk water pipeline which enters the Gamsberg Zinc Mine property was not considered as a separate environmental authorisation will be undertaken for the remaining section of the bulk water pipeline which will form part of the Gamsberg Smelter Project environmental authorisation process (Figure 1). The project area is surrounded by dry natural bare soil with grasslands in patches with minimal agriculture due to the dry climate. Due to the minimal rainfall and dry climate in the area, water is a scarce commodity with the Orange River serving as the main source of water for surrounding land users, one of which includes mining.

The Pella pipeline project is situated in the D81G and D82A quaternary catchments, within the Lower Orange Water Management Area (WMA). The proposed reticulation network will be crossing multiple tributaries of the Orange River (D81F – 3445 Sub Quaternary Reach) (SQR), in the Orange River Gorge – Aquatic Ecoregion. These tributaries include the 3rd order, 20.61 km long T_Goob se Laagte River (D81G – 03731 SQR) and associated drainage lines (D81G-3789/D81G-3804/ D81G-3855 and D81G-3840 SQR). The T_Goob se Laagte River is a largely natural (class B) river with a moderate Ecological status and sensitivity (DWS, 2020). The remaining watercourses of concern are the unnamed tributary of the ephemeral D81G – 03840 SQR and a tributary of the ephemeral D82A – 03779 SQR (Mik River).

The system at a desktop level is regarded as largely natural (Class B by DWS, 2020) due to water abstraction, alien invasive plants in riparian zones and subsistence farming.

The Lower Orange WMA is situated in the western extremity of South Africa, bordering on Botswana, Namibia and the Atlantic Ocean. The region has a harsh semi-desert to desert climate. Rainfall is minimal, ranging from 20 to 400 mm per annum with prolonged droughts. The Lower Orange WMA is entirely dependent on flow in the Orange River from upstream WMAs, with the exception of intermittent runoff from local tributaries and occasional inflows from the Fish River in Namibia. Important conservation areas in the WMA include the Kgalagadi Transfrontier National Park, the Augrabies National Park, the Richtersveld National Park and a transboundary Ramsar wetland site at the Orange River mouth. The economy is driven by mining (alluvial diamonds & other mineral resources) and irrigated agriculture. Extensive irrigation occurs along the Orange River. Sheep and other livestock farming is practised where the climate is favourable. Water resources in this WMA are fully developed due to the fact that water has to travel 1 400 km from its release at Vanderkloof Dam to the most downstream point of use (StatsSA, 2010).

The sampling points for the study were selected to adequately assess the current state of the Orange River and all the associated tributaries to identify the potential risks that may result from construction and operation of the Pella Bulk Water Pipeline. Sites were named according to the river on which they fall. O1 is on the Orange River (representing a downstream monitoring point for the whole operation), T1, T2, T3, T4, T5, T6, T7, T8 and T9 fall along the Te Goob se Laagte River and sites M1 and M2 are on the Mik River.

As a result, each reach was assessed at the proposed location of a pipeline crossing with a watercourse to gain a holistic image of the system and which habitat may be affected. The selected sampling location and the location of each crossing can be seen in Table 1 as well as Figure 1.

Table 1: Photos, co-ordinates and descriptions for the sites sampled (January 2020)

	Upstream	Downstream
O1 (Orange River)		
GPS	28°58'7.97"S 19° 7'29.82"E	
	Upstream	**Downstream**
T1 (Te Goob se Laagte River)		
GPS	28°58'4.94"S 19° 8'52.23"E	

	Upstream	Downstream
T2 (Te Goob se Laagte River)		
GPS	28°58'8.65"S 19° 8'49.90"E	
	Upstream	Downstream
T3 (Te Goob se Laagte River)		
GPS	28°58'11.13"S 19° 8'48.51"E	
	Upstream	Downstream
T4 (Te Goob se Laagte River)		
GPS	28°58'48.33"S 19° 8'31.45"E	

	Upstream	Downstream
T5 (Te Goob se Laagte River)		
GPS	28°59'10.79"S 19° 8'43.47"E	
	Upstream	Downstream
T6 (Te Goob se Laagte River)		
GPS	28°59'37.92"S 19° 8'33.63"E	
	Upstream	Downstream
T7 (Te Goob se Laagte River)		
GPS	28°59'56.58"S 19° 8'19.06"E	
T8 (Te Goob se Laagte River)		

	Upstream	Downstream
GPS	29° 0'11.15"S 19° 8'13.32"E	
	Upstream	**Downstream**
T9 (Te Goob se Laagte River)		
GPS	29° 3'55.07"S 19° 6'35.62"E	
	Upstream	**Downstream**
M1 (Mik River)		
GPS	29° 8'38.45"S 19° 0'50.44"E	
	Upstream	**Downstream**
M2 (Mik River)		
GPS	29° 9'1.82"S 19° 0'17.04"E	

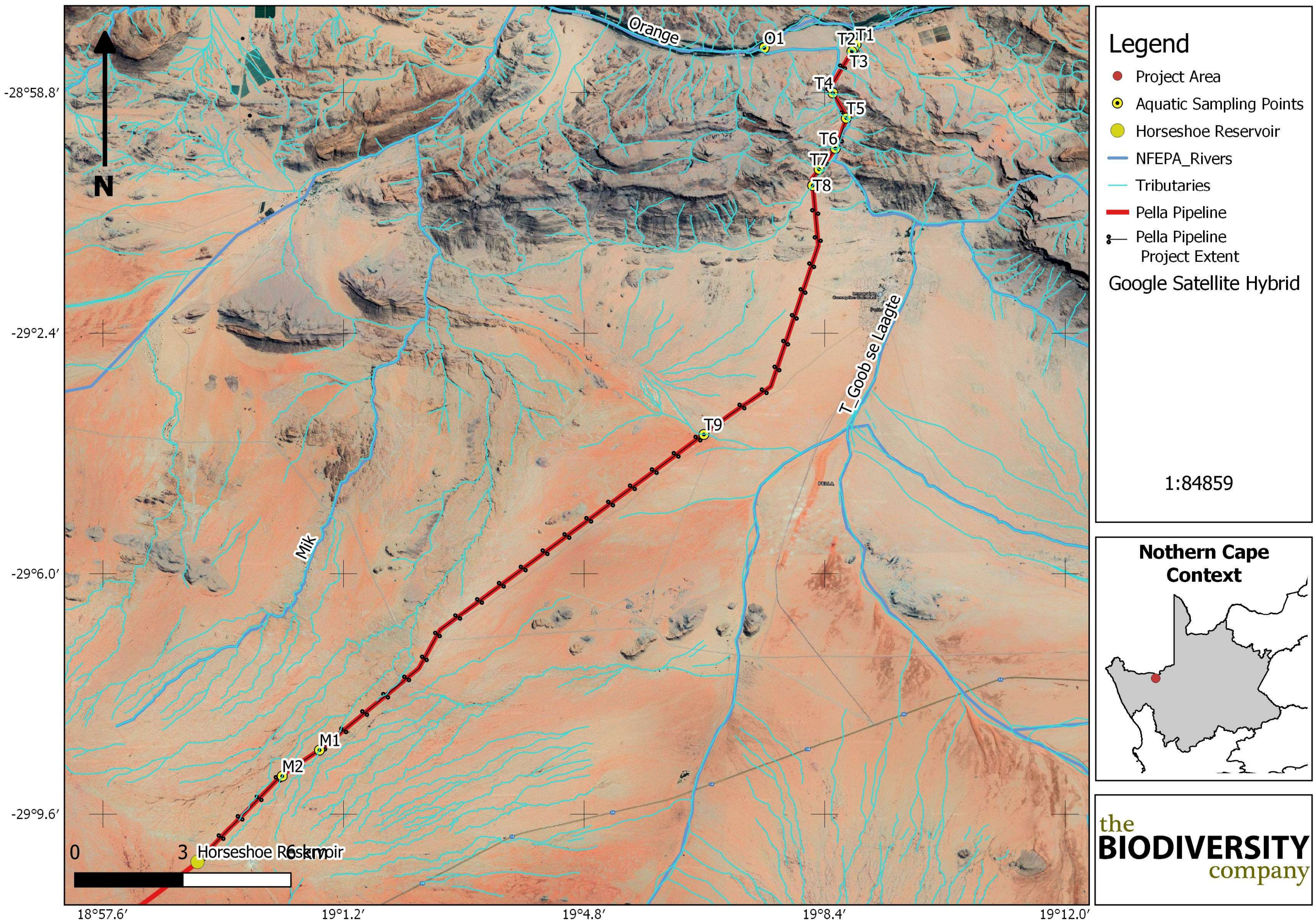

Figure 1: The location of the proposed pipeline and the assessed sites

3 Methodology

3.1 Aquatic Assessment

A single high flow survey was conducted in January 2020. While the period was considered high flow the region is experiencing a drought and therefore all ephemeral systems were dry. Standard methods were used to establish the baseline conditions of the considered river reaches. Details pertaining to the specific methodologies applied are provided in the relevant sections below.

3.1.1 Water Quality

Water quality was measured in situ using a handheld calibrated Extech® DO700 multi-meter. The constituents considered that were measured included: pH, conductivity (µS/cm), water temperature (°C) and Dissolved Oxygen (DO) in mg/l.

3.1.2 Aquatic Habitat Integrity

The Intermediate Habitat Assessment Index (IHIA) as described in the Procedure for Rapid Determination of Resource Directed Measures for River Ecosystems (Section D), 1999 was used to define the ecological status of the Orange River reach.

The IHIA model will be used to assess the integrity of the habitats from a riparian and in-stream perspective. The habitat integrity of a river refers to the maintenance of a balanced composition of physico-chemical and habitat characteristics on a temporal and spatial scale which are comparable to the characteristics of natural habitats of the region (Kleynhans, 1996).

This model compares current conditions with reference conditions that are expected to have been present. Specification of the reference condition follows an impact based approach where the intensity and extent of anthropogenic changes are used to interpret the impact on the habitat integrity of the system. To accomplish this, information on abiotic changes that can potentially influence river habitat integrity are obtained from surveys or available data sources. These changes are all related and interpreted in terms of modification of the drivers of the system, namely hydrology, geomorphology and physico-chemical conditions and how these changes would impact on the natural riverine habitats. The criteria and ratings utilised in the assessment of habitat integrity in the current study are presented in Table 2 and Table 3 respectively.

Table 2: Criteria used in the assessment of habitat integrity (Kleynhans, 1996)

Criterion	Relevance
Water abstraction	Direct impact on habitat type, abundance and size. Also implicated in flow, bed, channel and water quality characteristics. Riparian vegetation may be influenced by a decrease in the supply of water.
Flow modification	Consequence of abstraction or regulation by impoundments. Changes in temporal and spatial characteristics of flow can have an impact on habitat attributes such as an increase in duration of low flow season, resulting in low availability of certain habitat types or water at the start of the breeding, flowering or growing season.
Bed modification	Regarded as the result of increased input of sediment from the catchment or a decrease in the ability of the river to transport sediment. Indirect indications of sedimentation are stream bank and catchment erosion. Purposeful alteration of the stream bed, e.g. the removal of rapids for navigation is also included.
Channel modification	May be the result of a change in flow, which may alter channel characteristics causing a change in marginal instream and riparian habitat. Purposeful channel modification to improve drainage is also included.

Water quality modification	Originates from point and diffuse point sources. Measured directly or alternatively agricultural activities, human settlements and industrial activities may indicate the likelihood of modification. Aggravated by a decrease in the volume of water during low or no flow conditions.
Inundation	Destruction of riffle, rapid and riparian zone habitat. Obstruction to the movement of aquatic fauna and influences water quality and the movement of sediments.
Exotic macrophytes	Alteration of habitat by obstruction of flow and may influence water quality. Dependent upon the species involved and scale of infestation.
Exotic aquatic fauna	The disturbance of the stream bottom during feeding may influence the water quality and increase turbidity. Dependent upon the species involved and their abundance.
Solid waste disposal	A direct anthropogenic impact which may alter habitat structurally. Also, a general indication of the misuse and mismanagement of the river.
Indigenous vegetation removal	Impairment of the buffer the vegetation forms to the movement of sediment and other catchment runoff products into the river. Refers to physical removal for farming, firewood and overgrazing.
Exotic vegetation encroachment	Excludes natural vegetation due to vigorous growth, causing bank instability and decreasing the buffering function of the riparian zone. Allochtonous organic matter input will also be changed. Riparian zone habitat diversity is also reduced.
Bank erosion	Decrease in bank stability will cause sedimentation and possible collapse of the riverbank resulting in a loss or modification of both instream and riparian habitats. Increased erosion can be the result of natural vegetation removal, overgrazing or exotic vegetation encroachment.

Table 3: Descriptions used for the ratings of the various habitat criteria

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

3.1.3 Aquatic Macroinvertebrate Assessment

Macroinvertebrate assemblages are good indicators of localised conditions because many benthic macroinvertebrates have limited migration patterns or a sessile mode of life. They are particularly well-suited for assessing site-specific impacts (upstream and downstream studies) (Barbour *et al.,* 1999). Benthic macroinvertebrate assemblages are made up of species that constitute a broad range of trophic levels and pollution tolerances, thus providing strong information for interpreting cumulative effects (Barbour *et al.,* 1999). The assessment and monitoring of benthic macroinvertebrate communities forms an integral part of the monitoring of the health of an aquatic ecosystem.

3.1.3.1 Invertebrate Habitat

The invertebrate habitat at the site was assessed using the South African Scoring System version 5 (SASS5) biotope rating assessment as applied in Tate and Husted (2015). A rating system of 0 to 5 was applied, 0 being not available. The weightings for lowland rivers (slope class F) were used to categorize biotope ratings (Rowntree et al. 2000; Rowntree & Ziervogel, 1999).

3.1.3.2 South African Scoring System

The South African Scoring System version 5 (SASS5) is the current index being used to assess the status of riverine macroinvertebrates in South Africa. According to Dickens and Graham (2002), the index is based on the presence of aquatic invertebrate families and the perceived sensitivity to water quality changes of these families. Different families exhibit different sensitivities to pollution, these sensitivities range from highly tolerant families (e.g. Chironomidae) to highly sensitive families (e.g. Perlidae). SASS results are expressed both as an index score (SASS score) and the Average Score Per recorded Taxon (ASPT value).

Sampled invertebrates were identified using the "Aquatic Invertebrates of South African Rivers" Illustrations book, by Gerber and Gabriel (2002). Identification of organisms was made to family level (Thirion *et al.,* 1995; Dickens and Graham, 2002; Gerber and Gabriel, 2002).

All SASS5 and ASPT scores are compared with the SASS5 Data Interpretation Guidelines (Dallas, 2007) for the Orange River Gorge - Ecoregion (Figure 3). This method seeks to develop biological bands depicting the various ecological states and is derived from data contained within the Rivers Database and supplemented with other data not yet in the database.

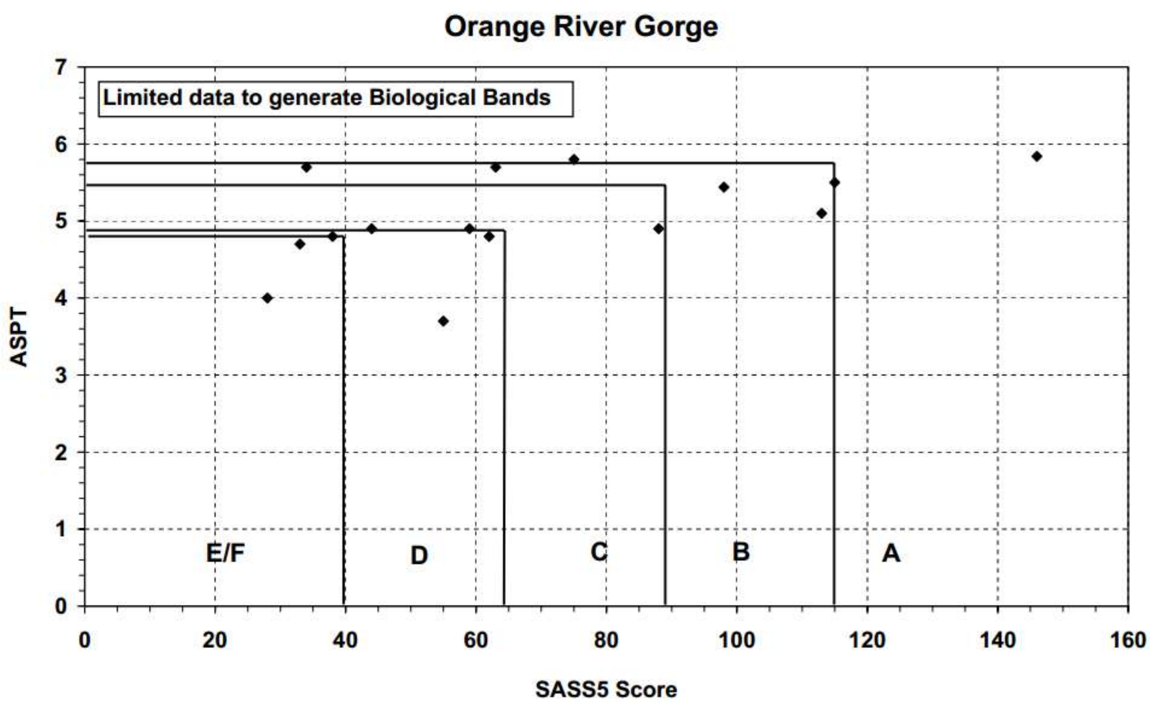

Figure 2: Biological Bands for the Orange River Gorge - Ecoregion, calculated using percentiles

3.2 Fish Presence

Fish were sampled through minnow traps and electroshocking (Figure 3). All fish were identified in the field and released at the point of capture, in order not to cross fish populations. Fish species were identified using the guide Freshwater Fishes of Southern Africa (Skelton, 2001). The identified fish species were compared to those expected to be present for the quaternary catchment. The expected fish species list for the reach was developed from a literature survey to compare to the sampled species at site. Different fish species represent different sensitivities to water chemistry, habitat and flow which considered as part of the Fish Response Assessment Index (FRAI) (Kleynhans *et al*., 2007 and Skelton 2001).

Figure 3: Example of methodology used to catch fish species (KZN, 2019).

3.3 Fish Response Assessment Index

Fish have different sensitivities or levels of tolerance to various aspects that they are subjected to within the aquatic environment. These tolerance levels are rated with a sensitivity score as presented in Table 4. These tolerance levels are scored to show each fish species' sensitivity to flow and physico-chemical modifications. The results indicate that fish collected in the Orange River are moderately tolerant to flow and physico-chemical modifications, respectively (Table 4). This applies as an average of the whole class and not each individual species.

Table 4: Intolerance rating and sensitivity of fish species

Sensitivity Score	Tolerance/Sensitivity Level
0-1	Highly tolerant = Very low sensitivity
1-2	Tolerant = Low sensitivity
2-3	Moderately tolerant = Moderate sensitivity
3-4	Moderately intolerant = High sensitivity
4-5	Intolerant = Very high sensitivity

Biological responses are important to consider and therefore the qualitative data obtained from the surveys was utilized in the FRAI (Kleynhans, 2007) and with the results presented below (Table 13). The Frequency of Occurrence (FROC) of the sampled fish community is calculated as follows: 0 = Absent; 1 = Present at very few sites (<10%); 2 = Present at few sites (>10-25%); 3 = Present at about >25-50% of sites; 4 = Present at most sites (>50- 75%); 5 = Present at almost all sites (>75%).

3.4 Impact Assessment

The risk assessment was completed according to the rating system provided by SLR Consulting (South Africa) (Pty) Ltd (2019). Each impact identified must be assessed in terms of intensity (severity), duration (temporal scale) and extent (spatial scale) which is used to calculate the consequence. The consequence along with probability (likelihood of occurring) are then used to calculate the significance of each associated risk. The following criteria must be applied:

PART A: DEFINITIONS AND CRITERIA*		
Definition of SIGNIFICANCE		**Significance = consequence x probability**
Definition of CONSEQUENCE		**Consequence is a function of intensity, spatial extent and duration**
Criteria for ranking of the INTENSITY of environmental impacts	**VH**	Severe change, disturbance or degradation. Associated with severe consequences. May result in severe illness, injury or death. Targets, limits and thresholds of concern continually exceeded. Substantial intervention will be required. Vigorous/widespread community mobilization against project can be expected. May result in legal action if impact occurs.
	H	Prominent change, disturbance or degradation. Associated with real and substantial consequences. May result in illness or injury. Targets, limits and thresholds of concern regularly exceeded. Will definitely require intervention. Threats of community action. Regular complaints can be expected when the impact takes place.
	M	Moderate change, disturbance or discomfort. Associated with real but not substantial consequences. Targets, limits and thresholds of concern may occasionally be exceeded. Likely to require some intervention. Occasional complaints can be expected.
	L	Minor (Slight) change, disturbance or nuisance. Associated with minor consequences or deterioration. Targets, limits and thresholds of concern rarely exceeded. Require only minor interventions or clean-up actions. Sporadic complaints could be expected.
	VL	Negligible change, disturbance or nuisance. Associated with very minor consequences or deterioration. Targets, limits and thresholds of concern never exceeded. No interventions or clean-up actions required. No complaints anticipated.
	VL+	Negligible change or improvement. Almost no benefits. Change not measurable/will remain in the current range.
	L+	Minor change or improvement. Minor benefits. Change not measurable/will remain in the current range. Few people will experience benefits.
	M+	Moderate change or improvement. Real but not substantial benefits. Will be within or marginally better than the current conditions. Small number of people will experience benefits.
	H+	Prominent change or improvement. Real and substantial benefits. Will be better than current conditions. Many people will experience benefits. General community support.
	VH+	Substantial, large-scale change or improvement. Considerable and widespread benefit. Will be much better than the current conditions. Favourable publicity and/or widespread support expected.
Criteria for ranking the DURATION of impacts	**VL**	Very short, always less than a year. Quickly reversible
	L	Short-term, occurs for more than 1 but less than 5 years. Reversible over time.
	M	Medium-term, 5 to 10 years.
	H	Long term, between 10 and 20 years. (Likely to cease at the end of the operational life of the activity)
	VH	Very long, permanent, +20 years (Irreversible. Beyond closure)
Criteria for ranking the EXTENT of impacts	**VL**	A part of the site/property.
	L	Whole site.
	M	Beyond the site boundary, affecting immediate neighbours
	H	Local area, extending far beyond site boundary.
	VH	Regional/National

PART B: DETERMINING CONSEQUENCE							
INTENSITY = VL							
DURATION	Very long	VH	Low	Low	Medium	Medium	High
	Long term	H	Low	Low	Low	Medium	Medium
	Medium term	M	Very Low	Low	Low	Low	Medium
	Short term	L	Very low	Very Low	Low	Low	Low
	Very short	VL	Very low	Very Low	Very Low	Low	Low
INTENSITY = L							
DURATION	Very long	VH	Medium	Medium	Medium	High	High
	Long term	H	Low	Medium	Medium	Medium	High
	Medium term	M	Low	Low	Medium	Medium	Medium
	Short term	L	Low	Low	Low	Medium	Medium
	Very short	VL	Very low	Low	Low	Low	Medium
INTENSITY = M							
DURATION	Very long	VH	Medium	High	High	High	Very High
	Long term	H	Medium	Medium	Medium	High	High
	Medium term	M	Medium	Medium	Medium	High	High
	Short term	L	Low	Medium	Medium	Medium	High
	Very short	VL	Low	Low	Low	Medium	Medium
INTENSITY = H							
DURATION	Very long	VH	High	High	High	Very High	Very High
	Long term	H	Medium	High	High	High	Very High
	Medium term	M	Medium	Medium	High	High	High
	Short term	L	Medium	Medium	Medium	High	High
	Very short	VL	Low	Medium	Medium	Medium	High
INTENSITY = VH							
DURATION	Very long	VH	High	High	Very High	Very High	Very High
	Long term	H	High	High	High	Very High	Very High
	Medium term	M	Medium	High	High	High	Very High
	Short term	L	Medium	Medium	High	High	High
	Very short	VL	Low	Medium	Medium	High	High
			VL	**L**	**M**	**H**	**VH**
			A part of the site/ property	Whole site	Beyond the site, affecting neighbours	Extending far beyond site but localised	Regional/ National
			EXTENT				

PART C: DETERMINING SIGNIFICANCE							
PROBABILITY (of exposure to impacts)	Definite/ Continuous	VH	Very Low	Low	Medium	High	Very High
	Probable	H	Very Low	Low	Medium	High	Very High
	Possible/ frequent	M	Very Low	Very Low	Low	Medium	High
	Conceivable	L	Insignificant	Very Low	Low	Medium	High
	Unlikely/ improbable	VL	Insignificant	Insignificant	Very Low	Low	Medium
			VL	**L**	**M**	**H**	**VVH**
			CONSEQUENCE				

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	Decision guideline
Very High	Potential fatal flaw unless mitigated to lower significance.
High	It must have an influence on the decision. Substantial mitigation will be required.
Medium	It should have an influence on the decision. Mitigation will be required.
Low	Unlikely that it will have a real influence on the decision. Limited mitigation is likely required.
Very Low	It will not have an influence on the decision. Does not require any mitigation
Insignificant	Inconsequential, not requiring any consideration.

3.5 Risk Assessment

The risk assessment will be completed in accordance with the requirements of the DWS General Authorisation (GA) in terms of Section 39 of the NWA for water uses as defined in Section 21(c) or Section 21(i) (GN 509 of 2016). The significance of the impact is calculated according to Table 5.

Table 5: Significance ratings matrix

Rating	Class	Management Description
1 – 55	(L) Low Risk	Acceptable as is or consider requirement for mitigation. Impact to watercourses and resource quality small and easily mitigated. Wetlands may be excluded.
56 – 169	M) Moderate Risk	Risk and impact on watercourses are notably and require mitigation measures on a higher level, which costs more and require specialist input. Wetlands are excluded.
170 – 300	(H) High Risk	Always involves wetlands. Watercourse(s)impacts by the activity are such that they impose a long-term threat on a large scale and lowering of the Reserve.

4 Limitations and Assumptions

The following aspects were considered as limitations of the assessment:

- A single aquatic ecology survey was completed for this assessment. Thus, temporal trends were not investigated.
- No baseline biomonitoring data/report(s) are available for the project area. Therefore, information presents the findings of the single aquatic survey.
- Due to the rapid nature of the assessment and the survey methods applied, fish diversity and abundance was likely to be underestimated.
- Invertebrates were only considered to the Family level and thus a defined species list for aquatic invertebrates was not completed. Therefore, the true sensitivities of macroinvertebrates species is not represented, causing an over or underestimation depending on the species.
- Due to the ephemeral nature of the river crossings these rivers could not be assessed.

5 Key Legislative Requirements

5.1 National Water Act (NWA, 1998)

The DHSWS is the custodian of South Africa's water resources and therefore assumes public trusteeship of water resources, which includes watercourses, surface water, estuaries, or aquifers. The National Water Act (Act No. 36 of 1998) (NWA) allows for the protection of water resources, which includes:

- The maintenance of the quality of the water resource to the extent that the water resources may be used in an ecologically sustainable way;
- The prevention of the degradation of the water resource; and
- The rehabilitation of the water resource.

A watercourse means:

- A river or spring;
- A natural channel in which water flows regularly or intermittently;
- A wetland, lake or dam into which, or from which, water flows; and
- Any collection of water which the Minister may, by notice in the Gazette, declare to be a watercourse, and a reference to a watercourse includes, where relevant, its bed and banks.

The NWA recognises that the entire ecosystem and not just the water itself, and any given water resource constitutes the resource and as such needs to be conserved. No activity may therefore take place within a watercourse unless it is authorised by the DWS. Any area within a wetland or riparian zone is therefore excluded from development unless authorisation is obtained from the DWS in terms of Section 21 (c) and (i).

5.2 National Environmental Management Act (NEMA, 1998)

The National Environmental Management Act (NEMA) (Act 107 of 1998) and the associated Regulations as amended in December 2014, states that prior to any development taking place within a wetland or riparian area, an environmental authorisation process needs to be followed. This could follow either the Basic Assessment Report (BAR) process or the Environmental Impact Assessment (EIA) process depending on the scale of the impact.

6 Desktop Assessment

6.1.1 National Freshwater Ecosystem Priority Areas (NFEPA)

The National Freshwater Ecosystem Priority Areas (NFEPA) database forms part of a comprehensive approach to the sustainable and equitable development of South Africa's scarce water resources. This database provides guidance on how many rivers, wetlands and estuaries, and which ones, should remain in a natural or near-natural condition to support the water resource protection goals of the National Water Act (Act 36 of 1998). This directly applies to the National

Water Act, which feeds into Catchment Management Strategies, water resource classification, reserve determination, and the setting and monitoring of resource quality objectives (Nel *et al.,* 2011). The NFEPAs are intended to be conservation support tools and envisioned to guide the effective implementation of measures to achieve the National Environment Management Biodiversity Act's biodiversity goals (NEM:BA) (Act 10 of 2004), informing both the listing of threatened freshwater ecosystems and the process of bioregional planning provided for by this Act (Nel *et al*., 2011).

According to Nel *et al.* (2011), the construction of the Pella Bulk Water Pipeline project area falls predominantly within a Sub-quaternary catchment along the D81F-03445 and D81G – 03731 Sub-Quaternary Reach's as well as the ephemeral D81G-3789, D81G-3804, D81G-3855, D81G-3840, D81G – 03840 and D82A – 03779 SQR's (Figure 12). Due to scale, all catchment labels are not visible but fall within the yellow square. The catchment is considered a River FEPA as well as a fish sanctuary for threatened species. As a result, all abstraction projects need to consider the water balance within the Orange River and associated tributaries as the systems in the FEPA need consideration to protect its ecological reserve.

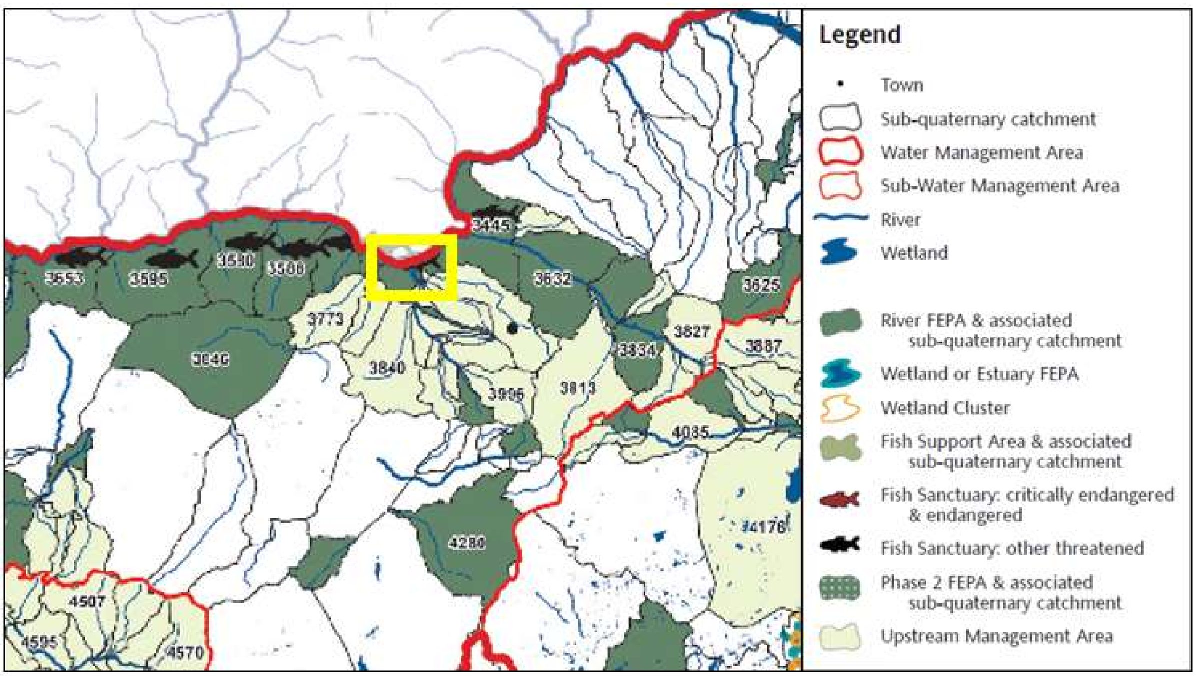

Figure 4: Map illustrating fish and river FEPAs for the project area, the project area is represented by the yellow square (Nel et al., 2011)

6.2 Status of sub-quaternary reach D81F-03445 and D81G – 03731

Desktop information for SQR's was obtained from DWS, 2020. The D81F-03445 SQR is a 7th order stream which spans 42 km. The PES category of the reach is classed as largely natural (class B) (Table 5). The D81G – 03731 SQR is a 3rd order stream which spans 20.61 km. The PES category of the reach is classed as largely natural (class B) (Table 5). The largely natural state of these reaches is due to impacts to instream habitat, wetland and riparian zone continuity, flow modifications and moderate potential impacts on physico-chemical conditions (water quality). Anthropogenic impacts identified within the Orange River sub-quaternary catchment include water abstraction, flow modification and alien invasive plant species. Anthropogenic impacts identified within the T_Goob se Laagte River sub-quaternary catchment include rural settlements, subsistence farming and exotic species. DWS has no associate desktop PES information for any ephemeral systems which includes the ephemeral D81G-3789, D81G-3804, D81G-3855, D81G-3840, D81G – 03840 and D82A – 03779 (Mik River) SQR's

Table 6: Summary of the Present Ecological State of the SQRs associated with the Orange River reach (DWS, 2020)

SQR Importance and Sensitivity	Score
D81F-03445 (Orange River)	
Present Ecological Status	Largely Natural (class B)
Ecological Importance	High
Ecological Sensitivity	High
Default Ecological Category	B
D81G – 03731 (T_Goob se Laagte)	
SQR Importance and Sensitivity	**Score**
Present Ecological Status	Largely Natural (class B)
Ecological Importance	Moderate
Ecological Sensitivity	Moderate
Default Ecological Category	C

6.3 Expected Fish Species

An expected species list was generated from DWS (2020), and Skelton (2011) for the D81F-03445 SQR's. A total of 13 fish species are expected to occur in the Orange River reach which are presented in Table 7. The conservational status of fish species was assessed against the IUCN database 2020 (IUCN, 2020).

The expected species are generated on a reach basis, and the occurrence of all species in the system is unlikely as different species are specialists of different habitats which are present along a reach. The Orange River reach does however have great diversity of habitat and therefore a wide range of fish species are expected. This includes one Vulnerable (V) species and one Near Threatened (NT) species.

The Near Threatened species identified is *Labeobarbus kimberleyensis* (Largemouth Yellowfish) and the Vulnerable species is *Oreochromis mossambicus* (Mozambique Tilapia). *Labeobarbus kimberleyensis* are silvery when young but are olive grey or light yellow as adults with light orange anal fin. This is the largest scale-bearing indigenous fish species in southern Africa. These fish prefer flowing water in deep channels or below rapids but do well in dams. These large fish are expert predators of insects and small crustaceans. *Oreochromis mossambicus* is a silvery olive to deep blue/grey in colour with a wide distribution throughout the eastern coast of Southern Africa. *O. mossambicus* occur in most systems except where there are fast flowing waters. The species thrive in standing waters and have a high tolerance to salinity. *O. mossambicus* feeds on plant matter and algae, however larger specimens have been known to be piscivorous (Skelton, 2001).

Table 7: Expected fish species

Species	Common Name	IUCN Status (2019)
Austroglanis sclateri	Rock Catfish	LC
Clarias gariepinus	Sharptooth Catfish / Barbel	LC
Engraulicypris brevianalis	Hyphen Barb	LC
Enteromius hospes	Namaquab Barb	LC
Enteromius paludinosus	Straightfin Barb	LC
Enteromius trimaculatus	Threespot Barb	LC
Labeobarbus aeneus	Vaal/Orange Smallmouth Yellowfish	LC
Labeobarbus kimberleyensis	Largemouth Yellowfish	NT
Labeo capensis	Orange River Mudfish	LC
Labeo umbratus	Moggel	LC
Oreochromis mossambicus	Mozambique Tilapia	VU
Pseudocrenilabrus philander	Southern mouth-brooder	LC
Tilapia sparrmanii	Banded Tilapia	LC

LC - Least Concern, NT – Near Threatened, VU - Vulnerable

7 Results and Discussion

7.1.1 *In situ* Water Quality

In situ water quality analysis was conducted during the study at each pipeline crossing which contained water as well as the downstream site. Results have been compared to limits stipulated in the Target Water Quality Range (TWQR) for aquatic ecosystems (DWS, 1996). The results of the January 2020 assessment are presented in Table 8.

Table 8: In situ surface water quality results (January 2020)

Site	pH	Electrical Conductivity (µS/cm)	Dissolved Oxygen (mg/l)	Temperature (°C)
TWQR*	**6.5-9***	**-**	**>5.00***	**5-30***
O1	7.78	246	8.12	36

*TWQR – Target Water Quality Range;   Levels exceeding guideline levels are indicated in red

In situ water quality for the Orange River indicates natural conditions as they conform with Target Water Quality Ranges (TWQR). The only parameter which was not compliant was water temperature. Water temperature affects other aspects of water chemistry. High water temperatures can increase the water solubility and thus toxicity from certain compounds such as heavy metals. This in turn effects conductivity as it affects the concentration, charge and mobility of the ions that EC measures. The solubility of oxygen and other gases will decrease as temperature increases (EPA, 2012). Lastly water temperatures have the potential to affect the metabolic rates and biological activity of aquatic organisms (Fink, 2005). The high-water temperatures in the Orange River are however due to heat transfer from solar radiation and considered natural for the system. The parameters indicate water quality which would not be a limiting factor to local aquatic biota. The construction of the reticulation network is not considered to modify the water quality of these systems significantly if appropriate mitigation measures prescribed in the risk assessment are followed.

7.1.2 Habitat Integrity Assessment

The IHIA was completed for the Orange River as described in the IHIA methodology component of this study. The special framework of which constitutes a 5km reach of the Orange River which would potentially be affected by the Pella Bulk Water Pipeline. The results thereof are shown in Table 9.

Table 9: Intermediate Habitat Integrity Assessment for the Orange River reach

Criterion	Impact Score	Weighted Score
Instream		
Water abstraction	5	2.8
Flow modification	4	2.1
Bed modification	5	2.6
Channel modification	4	2.1
Water quality	4	2.2
Inundation	3	1.2
Exotic macrophytes	0	0.0
Exotic fauna	0	0.0
Solid waste disposal	0	0.0
Total Instream Score		**87**
Instream Category		**B**
Riparian		
Indigenous vegetation removal	5	2.6
Exotic vegetation encroachment	6	2.9
Bank erosion	2	1.1
Channel modification	5	2.4
Water abstraction	8	4.2
Inundation	3	1.3
Flow modification	5	2.4
Water quality	3	1.6
Total Riparian Score		**81.56**
Riparian Category		**B**

The results of the instream and riparian habitat assessment in the associated Orange River indicates a largely natural state (class B). This indicates a small change in natural habitats and biota may have taken place, but the ecosystem functions are essentially unchanged. The sources of modification to the system are agriculture which uses irrigation from the system, regional water abstraction (Figure 22) as part of transfer schemes as well as alien invasive plant species.

Figure 5: Existing water extraction point for the bulk water pipeline (January 2020)

7.1.3 Aquatic Macroinvertebrate Assessment

7.1.3.1 Macroinvertebrate Habitat

Biological assessments were completed at representative sites in the considered river reach. The results of the biotope assessment are provided below (Table 10).

Table 10: Biotope availability at the sites (Rating 0-5)

Biotope	Weighting (Lowland River)	O1
Stones in current	15	4
Stones out of current	12	3
Bedrock	2	4
Aquatic Vegetation	0.5	2
Marginal Vegetation In Current	2	2.5
Marginal Vegetation Out Of Current	2	1
Gravel	0.5	2
Sand	4	2.5
Mud	1.5	0.5
Biotope Score		55
Weighted Biotope Score (%)		21.5
Biotope Category (Tate and Husted, 2015)		C

The habitat availability within the Orange River represents fair habitat conditions (class C) within the reach. There is a good distribution of habitat for macroinvertebrates to inhabit with no biotopes missing, however the abundance and distribution of vegetation out of current and mud were limited. The biotope results within the reach indicate that the habitat availability would not be a limiting factor for the macroinvertebrate communities within the Orange River.

7.1.3.2 South African Scoring System

The aquatic macroinvertebrate results for the survey are presented in Table 11.

Table 11: Macroinvertebrate assessment results recorded during the survey (January 2020)

Site	SASS Score	No. of Taxa	ASPT*	Category (Dallas, 2007)**
O1	159	30	5.3	A

*ASPT: Average score per taxon; ** Orange River Gorge ecoregion

The SASS5 assessment results generated SASS scores that are categorised as a class A for the Orange River reach (Dallas, 2007) which indicates natural conditions within the reach. The high number of taxa sampled during the survey are a clear indication that the sampled reach is in a natural condition (30). This high number of taxa increases the SASS Score which is one axis used to find the Dallas bands. This is considered significant as the reach is classed an A based on SASS score, but a C based on average score per taxon (ASPT). Both are considered for Dallas bands in an attempt to remove bias from highly intolerant and highly tolerant species in systems with low numbers of taxa. The ASPT indicated that not only tolerant taxa but also intolerant macroinvertebrates were collected during this survey. The tolerant macroinvertebrates include Oligochaeta (earthworms), Chironomidae (Blood worms) with some of the intolerant macroinvertebrates including three species of Baetidae, Leptophlebiidae (Prongills) and Tricorythidae (Stout Crawlers) to mention a few. The presence and wide distribution of specialist taxa across the biotopes along with high diversity of species indicates the current health of the system from a geomorphological, biological and chemical stance.

7.1.4 Fish Communities

The results of the qualitative fish community assessment are provided in Table 12. Eight fish species fish were observed during the survey. The most common species observed was *Labeo capensis* and *Oreochromis mossambicus* which were present throughout the survey. While there were five species which were not sampled it is assumed that, with increased efforts, these fish would be sampled due to presence of habitat required by these specialists. The two Near Threatened species identified of *Labeobarbus kimberleyensis* and *Oreochromis mossambicus* were sampled from the Orange River reach.

These fish were sampled from the downstream site in the Orange River which is expected to be minimally impacted on by the Pella Bulk Water Pipeline. The remaining watercourses are ephemeral and therefore dry.

Table 12: Fish community assessment for January 2020 (Orange River)

Species/Site	O1	Sensitivity	
		No-flow	Phys-chem
Austroglanis sclateri	-	3.2	2.6
Clarias gariepinus	5	1.7	1
Engraulicypris brevianalis	28	2.3	
Enteromius hospes	-	*	
Enteromius paludinosus	-	2.3	1.8
Enteromius trimaculatus	-	2.7	1.8
Labeobarbus aeneus	40	3.3	2.5
Labeobarbus kimberleyensis	2	3.8	3.6
Labeo capensis	88	3.1	
Labeo umbratus	-	2.7	1.6
Oreochromis mossambicus	62	0.9	1.3
Pseudocrenilabrus philander	15	1	1.4
Tilapia sparrmanii	58	0.9	1.4
Total Native Species	**8**	**2.3**	**2.03**
Total Expected Native Species	**12**		
% Fish Community Sampled	**67**		

0 = Absent; 1 = Present; * - no data available

Table 13: Fish Response Assessment Index for the 2020 survey

Scientific Name of Reference Species	Reference FROC*	FROC
		Orange River
Austroglanis sclateri	1	0
Clarias gariepinus	4	5
Engraulicypris brevianalis	2	5
Enteromius hospes	2	0
Enteromius paludinosus	3	0
Enteromius trimaculatus	3	0
Labeobarbus aeneus	5	5
Labeobarbus kimberleyensis	2	5
Labeo capensis	3	5
Labeo umbratus	2	0
Oreochromis mossambicus	3	5
Pseudocrenilabrus philander	3	5
Tilapia sparrmanii	3	5
FRAI % (Automated)	67.4	

EC FRAI	class C

FROC = Frequency of Occurrence

The results of the FRAI derived a moderately modified (class D) fish community structure for the sampled Orange River reach. The results need to be analysed with great precaution as the methodology requires multiple sites, with only one selected on the Orange River reach (Avenant., 2010). All tributary systems were dry and therefore not sampled, with multiple sites not selected on the Orange River as it was not the focus of the study. Due to the rapid nature of sampling there were species which were not collected; however, habitat was present, and the species are expected to be present. Therefore, provided more thorough analysis is undertaken, the system is suspected to score in a higher class (A/B). Only 33% of the fish species were not sampled with the vulnerable and near threatened species sampled which indicated good water quality and available habitat. The instillation of the underground Pella pipeline is expected to have minimal effects on the Orange River and its associated fish species.

8 Impact / Risk Assessment

The project is for the construction of the proposed Pella Bulk Water Pipeline, that will traverse several ephemeral watercourses. The entire proposed pipeline is aligned with existing dirt road and infrastructure servitudes with existing areas of impact. There are however points of crossing with ephemeral rivers. As this project is for the installation of a buried water pipeline, with all watercourses directly impacted being dry, impacts associated with the area are potentially low. Modifications to watercourses are likely to occur during construction with negligible impacts in the operation phase. The project will entail the clearing of minor amounts of re-established vegetation and levelling of areas for the construction activities. This has the potential to increase erosion and sedimentation of downstream habitats due to surface runoff during the wet season. This will however occur in an area which has been previously impacted by the same activities (existing pipeline).

Soluble construction materials have the potential to dissolve in runoff from the area. This can result in the increase of dissolved solids in downstream waterbodies resulting in a water quality impact. Further to this, suspended materials emanating from the construction area may alter the physical water parameters and result in the sedimentation of downstream areas which will have negative effects to local aquatic ecology. This impact will only occur during the construction phase as negligible impacts are foreseen beyond the construction phase. Further mitigating the potential effects is all assessed watercourses being dry allowing for large temporal scales in order to address spills before flow begins.

The impact assessment considered both direct and indirect impacts to the water resources. The mitigation hierarchy as discussed by the Department of Environmental Affairs (2013) will be considered for this component of the study (Figure 6). Risks which are assigned to the decommissioning phase of the pipeline are considered the same as during the construction phase.

In accordance with the mitigation hierarchy, the preferred mitigatory measure is to first avoid impacts by considering options in project location, siting, scale, layout, technology and phasing.

If avoidance isn't possible, associated risks should be minimised. In instances where impacts are unavoidable, rehabilitation will be required.

Findings from the impact assessment are provided in Table 14, Table 15 and Table 16. Findings from the DWS risk assessment are provided in Table 17 and Table 18.

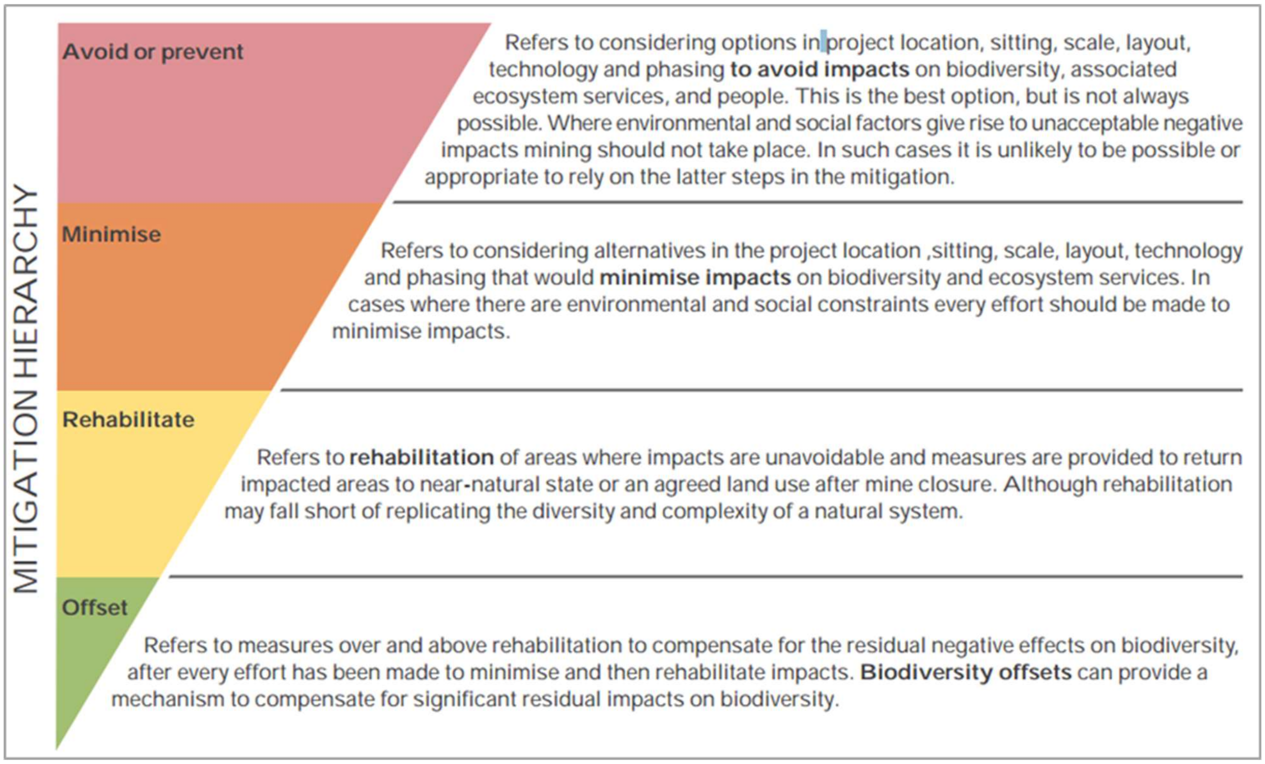

Figure 6: The mitigation hierarchy as described by the DEA (2013)

Table 14: Potential impacts associated with the project

Dale Kindler	Pr Sci Nat	114743
Activity	**Aspect**	**Impacts**
Construction of Pipeline	• Drainage patterns change due to crossing • Excavated streambed • Removal of embankment vegetation areas • Cutting/reshaping of embankments • Operation of equipment and machinery in riparian areas. • Soil and building material stockpile management • Domestic and industrial waste • Storage of chemicals, mixes and fuel • Final landscaping and post-construction rehabilitation	• Loss of embankments. • Siltation of watercourse. • Erosion of watercourse. • Increase in sediment inputs • Vegetation removal • Loss of seepage areas • Inundation of aquatic habitat • Alteration to future flow volumes
Operation of Pipeline	• Alteration of surface drainage and runoff • Storm water management • Establishment of alien plants on disturbed areas • Conducting maintenance	• Alteration to flow volumes (impediment) • Alteration of patterns of flows (increased flood peaks) • Solid waste

8.1 Impact / Risk Significance

A variety of risks have been identified for the proposed project. The construction of the Pella bulk water pipeline will entail the clearing of areas and digging of trenches, laying of pipeline and attachment of the pipeline to the existing crossing structures which will pose risks to the identified watercourses, with the level of risk determined to vary from low to very low.

An expected risk with buried pipeline projects would normally be a temporary channel diversion however this will not be required provided the construction is completed in the dry season. The impacted watercourses are ephemeral in nature and therefore with no water in the system, channel diversion will not be required. This also removes the concern of damming and inundation upstream from construction provided construction is completed swiftly.

It is however important to note that the ephemeral nature of the system is not reason to ignore appropriate protocols and mitigations as there is established habitat which becomes niches for aquatic macroinvertebrates and associated aquatic life when flow begins.

The risks barring two were determined to be low for the construction phase of the project. These result from work required within the watercourse such as machinery excavating streambeds at crossing points. This may result in spillages of chemicals, fuels and waste which can result in soil and future water degradation. It has the potential to result in flow modification from altered watercourses through construction which result in bed and channel modification. These are all considered as a low risk using the DWS risk matrix (Table 17 and Table 18).

The operation of the pipeline does pose a risk to the identified water resources, with the level of risk determined to be low in both the impact assessment and DWS risk assessment. While having the same assigned category as for many risks of the construction phase, the impact assessment does not assist in understanding the extent of each category, as the associated risks for the construction phase are considered more significant than the operational phase. The lower risk significance is largely attributed to the study being for a water reticulation project.

Taking into consideration that the project is for water reticulation, and that pipelines are generally aligned in road reserves and then branch up to the existing homesteads or storage facilities, the risks posed to watercourses is considered to be negligible. This is supported by the fact that the proposed pipeline will be replacing existing structures, indicating the area to already be disturbed.

The low risk ratings were re-allocated a very low status due to implementation of additional mitigation methodologies for the operational phase of the project. While the categories don't change the intensities, consequences of multiple risks are minimized during the construction phase.

Due to the low risks assigned to the project by the DWS risk assessment, authorisation under the provisions of the General Authorisation (GA) is deemed appropriate, provided mitigation measures and the recommendations are implemented.

Table 15: Impact Matrix for the proposed project – Pre Mitigation

ACTIVITY	APPLICABLE AREA	POTENTIAL ENVIRONMENTAL IMPACT	ENVIRONMENTAL SIGNIFICANCE					
			Intensity (I)	Duration (D)	Extent (E)	Consequences (C)	Probability (P)	Significance (S)
			Construction Phase					
Drainage patterns change due to crossing	Watercourse	Flow modification due to artificial structures such as gabions if required, as well as infiltration changes due to soil stratification and artificial material	M	L	VL	L	H	L
Excavated streambed	Watercourse	Habitat destruction for potential aquatic life. Changes in bed and channel modification which causes flow modification	H	VL	VL	L	VH	L
Removal of embankment vegetation areas	Watercourse and Riparian Areas	Removal of vegetation which keeps soil intact increases the risk of erosion as well as for alien vegetation to establish in its place.	M	L	VL	L	VH	L
Cutting/reshaping of embankments	Watercourse and Riparian Areas	Habitat destruction for potential aquatic life. Changes in bed and channel modification which causes flow modification	M	L	VL	L	VH	L
Operation of equipment and machinery in riparian areas	Riparian Areas	Habitat destruction for potential aquatic life. Changes in bed and channel modification which causes flow modification	M	L	VL	L	VH	L
Soil and building material stockpile management	Floodplain	Poor soil management causes changes in the soil profile which decreases fertility as well as increase the erosion potential. Erosion of stockpiles is high	L	L	VL	L	H	L
Domestic and industrial waste	Floodplain	Contamination risk if spills occur. Impaired soil and water quality.	VL	M	VL	VL	H	VL
Storage of chemicals, fuels & materials	Floodplain	Contamination risk if spills occur. Impaired soil and water quality.	VL	VL	VL	VL	H	VL
Final landscaping and post-construction rehabilitation	Watercourse and Riparian Areas	Considered a positive change to the landscape as the affected area by construction is returned to the state before construction began.	L+	L	VL	L	VH	L
			Operational Phase					
Alteration of surface drainage and runoff	Watercourse	Disturbed soils and potential artificial surfaces influence infiltration and runoff amounts and directions which effect course flow modification.	L	VH	VL	L	VH	L
Storm water management	Watercourse	Disturbed soils and potential artificial surfaces influence infiltration and runoff amounts and directions which affect course flow modification, exasperated by storm events.	VL	VH	L	L	H	L
Establishment of alien plants on disturbed areas	Riparian Areas and Floodplain	Due to disturbed soils and lack of competition from established vegetation, which was removed by construction, alien vegetation will establish	L	M	L	L	H	L
Conducting maintenance	Complete Project Area	When maintenance or repair is required the pipeline will need to be uncovered which has the assigned risk of all above risks at a smaller scale.	M	VL	L	L	VH	L

Very high – VH; High – H; High; Moderate - M; L – Low; Very Low – VL

Table 16: Impact Matrix for the proposed project – Post Mitigation

ACTIVITY	APPLICABLE AREA	POTENTIAL ENVIRONMENTAL IMPACT	ENVIRONMENTAL SIGNIFICANCE					
			Intensity (I)	Duration (D)	Extent (E)	Consequences (C)	Probability (P)	Significance (S)
			Construction Phase					
Drainage patterns change due to crossing	Watercourse	Flow modification due to artificial structures such as gabions if required, as well as infiltration changes due to soil stratification and artificial material	L	L	VL	L	M	VL
Excavated streambed	Watercourse	Habitat destruction for potential aquatic life. Changes in bed and channel modification which causes flow modification	M	VL	VL	L	VH	L
Removal of embankment vegetation areas	Watercourse and Riparian Areas	Removal of vegetation which keeps soil intact increases the risk of erosion as well as for alien vegetation to establish in its place.	L	L	VL	L	VH	L
Cutting/reshaping of embankments	Watercourse and Riparian Areas	Habitat destruction for potential aquatic life. Changes in bed and channel modification which causes flow modification	M	L	VL	L	H	L
Operation of equipment and machinery in riparian areas	Riparian Areas	Habitat destruction for potential aquatic life. Changes in bed and channel modification which causes flow modification	L	L	VL	L	VH	L
Soil and building material stockpile management	Floodplain	Poor soil management causes changes in the soil profile which decreases fertility as well as increase the erosion potential. Erosion of stockpiles is high	L	L	VL	L	H	L
Domestic and industrial waste	Floodplain	Contamination risk if spills occur. Impaired soil and water quality.	VL	M	VL	VL	M	VL
Storage of chemicals, fuels & materials	Floodplain	Contamination risk if spills occur. Impaired soil and water quality.	VL	VL	VL	VL	H	VL
Final landscaping and post-construction rehabilitation	Watercourse and Riparian Areas	Considered a positive change to the landscape as the affected area by construction is returned to the state before construction began.	L+	L	VL	L	VH	L
			Operational Phase					
Alteration of surface drainage and runoff	Watercourse	Disturbed soils and potential artificial surfaces influence infiltration and runoff amounts and directions which affect cause flow modification.	VL	VH	VL	L	L	VL
Storm water management	Watercourse	Disturbed soils and potential artificial surfaces influence infiltration and runoff amounts and directions which affect cause flow modification, exasperated by storm events.	VL	VH	VL	L	L	VL
Establishment of alien plants on disturbed areas	Riparian Areas and Floodplain	Due to disturbed soils and lack of competition from established vegetation, which was removed by construction, alien vegetation will establish	VL	L	L	VL	M	VL
Conducting maintenance	Complete Project Area	When maintenance or repair is required the pipeline will need to be uncovered which as the assigned risk of all above risks at a smaller scale.	L	VL	VL	VL	VH	VL

Very high – VH; High – H; High; Moderate - M; L – Low; Very Low – VL

Table 17: DWS Risk Impact Matrix for the proposed project

Aspect	Flow Regime	Water Quality	Habitat	Biota	Severity	Spatial scale	Duration	Consequence
Construction Phase								
Drainage patterns change due to crossing	2	1	1	1	1.33	1	2	4.33
Excavated streambed	1	1	2	1	1.25	1	2	4.25
Removal of embankment vegetation areas	2	1	3	1	1.75	2	2	5.75
Cutting/reshaping of embankments	3	1	2	1	1.75	1	2	4.75
Operation of equipment and machinery in riparian areas	2	2	2	1	1.75	2	2	5.75
Soil and building material stockpile management	1	2	1	1	1.25	1	2	4.25
Domestic and industrial waste	1	2	1	1	1.25	2	2	5.25
Storage of chemicals, mixes and fuel	1	2	2	1	1.5	1	2	4.5
Final landscaping and post-construction rehabilitation	1	1	2	1	1.25	2	2	5.25
Operational Phase								
Alteration of surface drainage and runoff	1	1	2	1	1.25	1	4	6.25
Storm water management	1	2	1	1	1.25	2	4	7.25
Establishment of alien plants on disturbed areas	1	2	1	1	1.25	2	2	5.25
Conducting maintenance	2	2	2	1	1.75	2	4	7.75

Table 18: DWS Risk Impact Matrix for the proposed project continued

Aspect	Frequency of activity	Frequency of impact	Legal Issues	Detection	Likelihood	Sig.	Without Mitigation	With Mitigation
Construction Phase								
Drainage patterns change due to crossing	1	2	5	3	11	47.67	Low	Low
Excavated streambed	1	4	5	1	11	46.75	Low	Low
Removal of embankment vegetation areas	1	3	1	2	7	40.25	Low	Low
Cutting/reshaping of embankments	1	2	5	1	9	42.75	Low	Low
Operation of equipment and machinery in riparian areas.	1	3	1	1	6	34.5	Low	Low
Soil and building material stockpile management	1	1	1	1	4	17	Low	Low
Domestic and industrial waste	4	1	1	2	8	42	Low	Low
Storage of chemicals, mixes and fuel	1	1	1	2	5	22.5	Low	Low
Final landscaping and post-construction rehabilitation	1	1	1	1	4	21	Low	Low
Operational Phase								
Alteration of surface drainage and runoff	1	1	5	1	8	50	Low	Low
Storm water management	2	2	1	1	6	43.5	Low	Low
Establishment of alien plants on disturbed areas	2	2	1	2	7	36.75	Low	Low
Conducting maintenance	1	1	1	1	4	31	Low	Low

8.2 Mitigation Measures

The prescribed mitigation measures for the project include the following:

8.2.1.1 Water pipeline installation specific mitigation measures

- The footprint area of the pipeline must be kept to a minimum. The footprint area must be clearly demarcated to avoid unnecessary disturbances to adjacent areas;
- The footprint area must be aligned with the existing pipeline or existing road reserves wherever possible. Disturbed areas should be sought as the preferred alignment area;
- Pipeline trenches and sandy bedding material may produce preferential flow paths for water across the project area perpendicular to the general direction of flow. This risk can be reduced by installing clay plugs at intervals down the length of the trench to force water out of the trench and down the natural topographical gradient;
- Due to the flat gradient of these watercourses, it is imperative that after burial the trenches are not raised or depressed as it will produce artificial flow directions.
- Pipelines buried underground should be buried at a sufficient depth below ground level such that the pipelines do not interfere with surface water movement or create obstructions, where flows can cause erosion;
- The pipeline should be regularly inspected (yearly) for any signs of failure, damage or leaks. Adequate maintenance measures need to be implemented upon finding pipeline issues and failures; and
- Inspection points must be located outside of watercourses.

8.2.1.2 General mitigation measures

The following general mitigation measures are provided:

- The construction vehicles and machinery must make use of existing access routes as much as possible, before adjacent areas are considered for access;
- Laydown yards, camps and storage areas must be beyond the aquatic areas delineated watercourse extend and associated buffer zones). Where possible, the construction of the pipeline and crossings must take place from the existing road servitudes and not from within the aquatic systems;
- The contractors used for the project should have spill kits available to ensure that any fuel or oil spills are cleaned-up and discarded correctly;
- It is preferable that construction takes place during the dry season to reduce the erosion potential of the exposed surfaces; as well as guarantee dry watercourses. If construction will exceed this temporal scale (one season), construction should be halted during storm events only;
- Prevent uncontrolled access of vehicles through the rivers that can cause future significant adverse impact on the hydrology and alluvial soil structure of these areas;

- All chemicals and toxicants to be used for the pipeline construction must be stored outside the channel system and in a bunded area;
- All machinery and equipment should be inspected regularly for faults and possible leaks, these should be serviced off-site;
- All contractors and employees should undergo induction which is to include a component of environmental awareness. The induction is to include aspects such as the need to avoid littering, the reporting and cleaning of spills and leaks and general good "housekeeping";
- Adequate sanitary facilities and ablutions on the servitude must be provided for all personnel throughout the project area. Use of these facilities must be enforced (these facilities must be kept clean so that they are a desired alternative to the surrounding vegetation);
- All removed soil and material must not be stockpiled within the system. Stockpiling should take place outside of the watercourse. All stockpiles must be protected from erosion, stored on flat areas where run-off will be minimised, and be surrounded by bunds;
- Erosion and sedimentation into drainage channels must be minimised through the effective stabilisation if required (gabions and Reno mattresses) (see site M1) and the re-vegetation of any disturbed banks;
- Any exposed earth should be rehabilitated promptly by planting suitable vegetation (vigorous indigenous grasses) to protect the exposed soil. Large portions of the natural area is bare soil and should be kept as such;
- No dumping of construction material on-site may take place;
- All waste generated on-site during construction must be adequately managed. Separation and recycling of different waste materials should be supported; and
- An alien invasive plant management plan needs to be compiled and implemented post construction to control current invaded areas and prevent the growth of invasives on cleared areas.

8.2.2 Recommendations

The following are recommendations made in support of the Riverine Baseline assessment:

- A soil management strategy must be compiled and implemented for the excavation and back-filling of trenches. A proposed soil handling sequence is presented in Figure 7.
- An infrastructure monitoring and service plan must be compiled and implemented during the operational phase. Selected points must avoid watercourses.
- An Environmental Control Officer (ECO) must oversee the construction phase of the project.

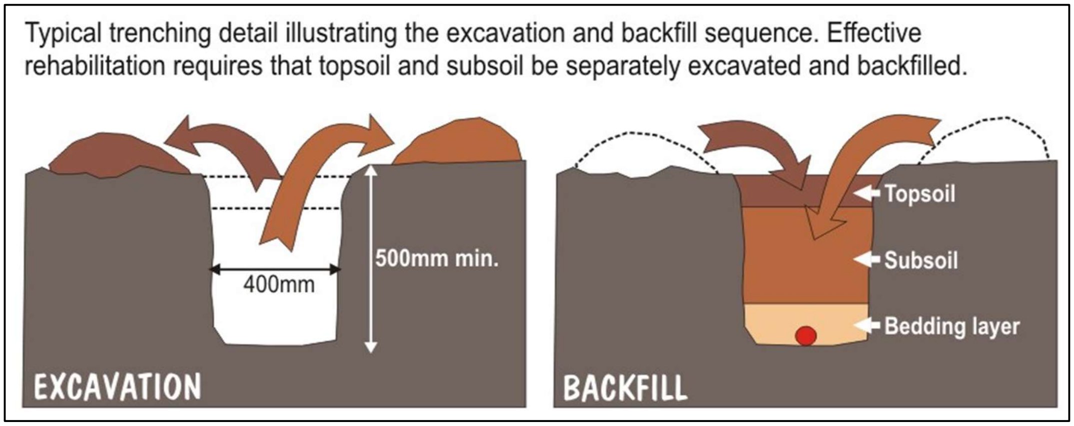

Figure 7: The proposed excavation and back-filling handling of soil

9 Conclusion

9.1 Aquatics baseline

The Orange River (D81F-03445 SQR's) from which water will be sourced for the proposed reticulation network is considered to be largely natural (B) at desktop level (PES). The reach has high Ecological Importance and Ecological Sensitivity. This was confirmed through the baseline survey where water quality indicated natural conditions. Aquatic macroinvertebrate species were found to be both abundant and diverse indicating the current health of the system from a geomorphological, biological and chemical stance. The SASS5 assessment results generated SASS scores that are categorised as a class A for the Orange River reach.

A total of 13 indigenous fish species are expected within the reach, with one near threatened species (*Labeobarbus kimberleyensis*) and one vulnerable species (*Oreochromis mossambicus*). Eight of the thirteen species were sampled during the survey which included both red list species. FRAI derived a score of moderately modified (class D) with a higher expected score with increased sampling efforts as habitat for missing species was present.

The available habitat within the reach was in a largely natural state in both the riparian and instream areas. The largest modifiers were water abstraction and exotic vegetation encroachment.

All watercourses are expected to experience minimal impacts from the proposed pipeline due to their temporal and spatial reference to the project.

9.2 Risk Assessment

A variety of risks have been identified for the proposed project for both the construction and operational phase. The impacts of which all stem from construction within a defined watercourse. The associated risks are however significantly lowered due to the ephemeral nature of the watercourses but are not absent as the watercourse still forms important habitat for aquatic life when they do flow.

Taking into consideration that the project is for water reticulation, and that pipelines are generally aligned in road reserves and then branch up to the existing homesteads, the risks posed to watercourses are considered negligible. This is supported by the fact that the proposed pipeline will also replace existing structures, indicating the area to already be disturbed. This statement is however only considered valid provided the attributed mitigation measures are considered and implemented.

9.3 Specialist Recommendation

It is the opinion of the specialists that the project poses no fatal flaws and the project qualifies for authorisation under the provisions of the General Authorisation. After burial the pipeline will have negligible effects on the associated watercourse.

10 References

Avenant, M.F., 2010. Challenges in using fish communities for assessing the ecological integrity of non-perennial rivers. Water SA, 36(4).

Barbour, M.T., Gerritsen, J. & White, J.S. 1996. Development of a stream condition index (SCI) for Florida. Prepared for Florida Department of Environmental Protection: Tallahassee, Florida.

Dallas, H.F. 2007. River Health Programme: South African Scoring System (SASS) Data Interpretation Guidelines. Report produced for the Department of Water Affairs and Forestry (Resource Quality Services) and the Institute of Natural Resources.

Department of Water Affairs and Forestry (DWAF). 1996. South African Water Quality Guidelines. Volume 7: Aquatic Ecosystems.

Department of Water and Sanitation (DWS). 2020. A Desktop Assessment of the Present Ecological State, Ecological Importance and Ecological Sensitivity per Sub Quaternary Reaches for Secondary Catchments in South Africa. Draft. Compiled by RQS-RDM.

Dickens, C. W. S. and Graham, P.M. 2002. The South African Scoring System (SASS) Version 5: Rapid bioassessment method for rivers. African Journal of Aquatic Science. 27 (1): 1 -10.

Environmental Protection Agency (EPA). 2012. Channel Processes: Suspended Sediment Transport. In Water: Science & Technology. Retrieved from http://water.epa.gov/scitech/datait/tools/warsss/suspend.cfm

Fink, J. C. 2005. Chapter 4 – Establishing a Relationship Between Sediment Concentrations and Turbidity. In The Effects of Urbanization on Baird Creek, Green Bay, WI (Thesis). Retrieved from http://www.uwgb.edu/watershed/fink/Fink_Thesis_Chap4.pdf

Gerber, A. & Gabriel, M.J.M. 2002. Aquatic Invertebrates of South African Rivers Field Guide. Institute for Water Quality Studies. Department of Water Affairs and Forestry. 150pp

International Union for Conservation of Nature and Natural Resources (IUCN). (2020). Red list of threatened species - 2019.2. www.iucnredlist.org. (Accessed in January 2020)

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

Kleynhans CJ. 2007. Module D: Fish Response Assessment Index in River EcoClassification: Manual for EcoStatus Determination (version 2) Joint Water Research Commission and Department of Water Affairs and Forestry report. WRC Report No.

Nel JL, Murray KM, Maherry AM, Petersen CP, Roux DJ, Driver A, Hill L, Van Deventer H, Funke N, Swartz ER, Smith-Adao LB, Mbona N, Downsborough L and Nienaber S. 2011. Technical Report for the National Freshwater Ecosystem Priority Areas project. WRC Report No. K5/1801.

Rowntree, K. and Ziervogel, G., 1999. Development of an Index of Stream Geomorphology for the Assessment of River Health. National Aquatic Ecosystem Biomonitoring Programme.

Rountree KM, Wadeson RA and O'Keeffe J. 2000. The Development of a Geomorphological Classification System for the Longitudinal Zonation of South African Rivers. South African Geographical Journal 82 (3): 163-172.

Skelton, P.H. (2001). A complete guide to the freshwater fishes of southern Africa. Struik Publishers, South Africa.

Tate RB, Husted A. 2015. Aquatic macroinvertebrate responses to pollution of the Boesmanspruit river system above Carolina, South Africa. *African Journal of Aquatic Science*. 1-11.

Thirion, C.A., Mocke, A. & Woest, R. 1995. Biological monitoring of streams and rivers using SASS4. A User's Manual. Internal Report No. N 000/00REQ/1195. Institute for Water Quality Studies. Department of Water Affairs and Forestry.

Wepener V, Van Vuren JHJ, Chatiza FP, Mbizi Z, Slabbert L, Masola B. 2005. Active biomonitoring in freshwater environments: early warning signals from biomarkers in assessing biological effects of diffuse sources of pollutants. Physics and Chemistry of the Earth 30: 751–761.