63 Wessel Road, Rivonia, 2128 PO Box 2597, Rivonia, 2128 South Africa
Tel: +27 (0) 11 803 5726 **Fax:** +27 (0) 11 803 5745 **Web:** www.gcs-sa.biz

Exxaro Leeuwpan Coal Mine
Section 21(a)
Water Use Licence Application (WULA)

Report

Version – Public Review

04 March 2021

Exxaro Resources Ltd

GCS Project Number: 19-0902

Client Reference: PO: 4512334972



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Document Reviewer	Kate Cain		04 March 2021
Unit Director	Adam Gunn		04 March 2021

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EXECUTIVE SUMMARY

Exxaro Leeuwpan Coal Mine (Leeuwpan) began as an Iscor Mine in 1991, doing extensive exploration with the first box-cut commencing in 1992. Leeuwpan is currently an operational mine and became known as Exxaro Leeuwpan Coal Mine in 2007. Leeuwpan is located 10 kilometres (km) south east of Delmas, in the Victor Khanye Local Municipality. The mine falls within the Nkangala District Municipality in the Mpumalanga Province.

Leeuwpan is situated in the upper reaches of the Bronkhorstspruit catchment in quaternary catchment B20A. In compliance with the National Water Act, 1998 (Act No. 36 of 1998) (NWA), the Department of Water and Sanitation (DWS) [now the Department of Human Settlements, Water and Sanitation (DHSWS)] issued an Integrated Water Use Licence (IWUL) to Leeuwpan (Licence No. 04/B21A/ABCGIJ/429) on the 25th March 2011. The IWUL was issued for various water uses being undertaken on site in terms of Section 21 of the NWA. The license was issued for the following water uses:

- Section 21(a) – Taking of water from a water resource;
- Section 21(b) – Storing of Water;
- Section 21(c) – Impeding or diverting the flow of water in a watercourse;
- Section 21(g) – Disposing of waste in a manner which may detrimentally impact on a water resource;
- Section 21(i) – Altering the bed, banks, course or characteristics of a watercourse; and
- Section 21(j) – Removing, discharging or disposing of water found underground.

An amendment to the IWUL for Leeuwpan was also issued in terms of Section 50 and Section 158 of the NWA on the 18th December 2015. This amendment was issued to amend / correct water uses licensed as part of the IWUL issued on the 25th March 2011. The following water uses in terms of Section 21 of the NWA were amended:

- Section 21(a) – Taking of water from a water resource;
- Section 21(c) – Impeding or diverting the flow of water in a watercourse;
- Section 21(g) – Disposing of waste in a manner which may detrimentally impact on a water resource;
- Section 21(i) – Altering the bed, banks, course or characteristics of a watercourse; and
- Section 21(j) – Removing, discharging or disposing of water found underground.

A separate Integrated Water Use Licence Application (IWULA) was submitted to authorise water uses associated with the mining of the Block OI and OL Expansion. The IWUL was

awarded to Leeuwpan (Licence No. 04/B20A/CIJ/4032) on the 18th December 2015. The IWUL was issued for various water uses required for the expansion project in terms of Section 21 of the NWA. The license was issued for the following water uses:

- Section 21(a) – Taking of water from a water resource;
- Section 21(c) – Impeding or diverting the flow of water in a watercourse;
- Section 21(g) – Disposing of waste in a manner which may detrimentally impact on a water resource;
- Section 21(i) – Altering the bed, banks, course or characteristics of a watercourse; and
- Section 21(j) – Removing, discharging or disposing of water found underground.

An additional application was submitted to expand mining Block OI to include the area where planned infrastructure would have originally been located. This expansion area is referred to as OI West. Water uses for this expansion are triggered in terms of Section 21(c) and (i) of the NWA. The IWUL was awarded to Leeuwpan (Licence No. 06/B20A/CI/9521) on the 4th March 2020. The license was issued for the following water uses:

- Section 21(c) – Impeding or diverting the flow of water in a watercourse; and
- Section 21(i) – Altering the bed, banks, course or characteristics of a watercourse.

Following a meeting with the DHSWS, the DHSWS indicated that Leeuwpan requires authorisation in the form of a Water Use License (WUL) for the abstraction of water from the Witklip borehole (Witklip Borehole 1) for operations at the Leeuwpan Coal Mine. This borehole was not licensed as part of the authorisations previously issued and was previously been listed as an Existing Lawful Water Use (ELWU) in previous reports. DHSWS have however, requested that an application be made to license this abstraction. In addition, a second borehole (Witklip Borehole 2) is being applied for as a backup supply borehole to supplement Witklip borehole 1 water if water cannot be abstracted from it. Abstraction of water from the two boreholes triggers a water use in terms of Section 21(a) 'taking water from a water resource' of the NWA. The authorisation process requires that an application in the form of a Water Use License Application (WULA) be undertaken.

GCS Water and Environment (Pty) Ltd (GCS) were appointed to undertake the WULA process in order to authorise the required abstractions. This report serves as the technical application report pertaining to the Section 21(a) WULA.

Current Mining:

Mining at Leeuwpan is carried out by opencast methods, involving blasting and truck and shovel operations. Leeuwpan is an existing coal mining operation with existing infrastructure associated with the following mining areas:

- Block OMW;
- Weltevreden;
- Block OL; and
- Block OI and OI West

Water Use to be Licenced:

The water abstracted from the Witklip Borehole 1 will be used for coal processing and domestic water supply. The water, once abstracted from the borehole, is pumped to the Silver Tank where it is distributed to the plant as well as the mining area, mining offices and the engineering workshops for domestic use. The borehole water will not be used for drinking purposes. The proposed daily abstraction for Witklip Borehole 1 of 602.74m^3/day amounts to an average annual abstraction of 220 000m^3/year.

The Witklip Borehole 2 has also been included as part of this application process as it will be used as a backup supply borehole should there be any reason that water cannot be abstracted from Witklip Borehole 1 (e.g. pump maintenance). The proposed daily abstraction for Witklip Borehole 2 of 100m^3/day amounts to an average annual abstraction of 36 500 m^3/year. It must be noted that water will not be abstracted from both boreholes at the same time.

The total abstraction triggers the following water use in terms of the NWA:

- Section 21(a) – taking water from a water resource.

The details of the water uses to be licensed is presented in the Table below:

Table 8.1 Section 21(a) Water Uses

Water Uses					
Water Use No.	**Section 21(a) Water Use Description**	**Site Name**	**Co-ordinates**	**Property**	**Volume (m^3/a)**
1	Groundwater abstraction for operational use	WK-BH1	26°10'23.88"S 28°42'36.47"E	Witklip 229 IR Portion 4	183 500m^3/a (502.74m^3/day)
2	Groundwater abstraction for operational use (Back-up water for WK-BH1)	WK-BH2	26°10'19.18"S 28°43'10.90"E	Wolvenfontein 224 IR Portion 8	36 500m^3/a (100m^3/day)
Total abstraction from both boreholes					**220 000m^3/a**

The NWA requires that water used as defined in terms of Section 21 be licensed and authorised by the DWS. This report serves as the technical application report for the Water

Use License Application (WULA) for the abstraction of water from the Witklip borehole 1 (WK-BH1) and Witklip Borehole 2 (WK-BH2).

Potential Environmental Impacts:

The following potential impact will have to be monitored and evaluated:

- Impact of abstraction on surrounding groundwater levels.

The impact identified and mitigation measures provided are detailed in Section 5 of this report.

CONTENTS PAGE

1 INTRODUCTION 1
1.1 Activity Background 1
1.2 Contact Details 2
1.3 Regional Setting and Location of Activity 2
1.3.1 Magisterial District and Local Municipality 2
1.4 Property Description 5
2 CONCEPTUALISATION OF THE ACTIVITY 7
2.1 Description of the Activity 7
2.1.1 Existing Operations 7
2.2 Extent of the Activity 9
2.3 Key Activity Related Processes and Product 9
2.3.1 Mining Method 9
2.3.2 Mineral Processing 9
2.3.3 Product 10
2.4 Activity Life Description 10
2.5 Activity Infrastructure Description 11
2.5.1 Kenbar and Witklip 11
2.5.2 Block OE 11
2.5.3 Block OD, OFPAD, OH and OM 12
2.5.4 Block OJ and OL 12
2.5.5 Block OD, OI and OWM 12
2.6 Key Water Uses and Waste Streams 15
2.6.1 Key Water Uses 15
2.6.2 Key Waste Streams 16
2.7 Organisational Structure of the Activity 16
2.8 Business and Corporate Policies 18
2.8.1 Safety, Health and Environmental Policy 18
2.8.2 Objectives and Strategies 19
3 REGULATORY WATER AND WASTE MANAGEMENT FRAMEWORK 20
3.1 Summary of all Water Uses 20
3.2 Existing Lawful Water Uses 28
3.3 Relevant Exemptions 29
3.4 Generally Authorised Water Uses 30
3.5 New Water Uses to be Licensed 30
3.6 Waste Management Activities and Waste Related Authorisations 32
3.6.1 Domestic Waste 32
3.6.2 Mine Waste 32
3.6.3 Hazardous Waste 32
3.7 Other Authorisations and Regulations 33
3.8 Legal Assessment 33
3.8.1 The Constitution of South Africa, 1996 (Act No.108 of 1996) 34
3.8.2 The National Environmental Management Act, 1998 (Act No.107 of 1998) 35
3.8.3 The Mineral and Petroleum Resources Development Act, 2002 (Act No.48 of 2002) 36
3.8.4 The National Water Act, 1998 (Act No.36 of 1998) 37
4 PRESENT ENVIRONMENTAL SITUATION 39
4.1 Climate 39
4.1.1 Regional Climate 39
4.1.2 Rainfall 39
4.1.3 Evaporation 40
4.2 Surface Water 40

4.2.1 Water Management Area 40
4.2.2 Surface Water Hydrology 42
4.2.3 Surface Water Quality 42
4.2.4 Mean Annual Runoff 45
4.2.5 Resource Class and River Health 46
4.2.6 Surface Water User Survey 47
4.2.7 Sensitive Areas (Wetlands) 48
4.3 GROUNDWATER 55
4.3.1 Aquifer Characterisation 55
4.3.2 Groundwater Quality 60
4.3.3 Hydrocensus 66
4.3.4 Potential Pollution Source Identification 76
4.3.5 Analytical Groundwater Model 76
4.3.6 Acid Mine Drainage Plan 84
4.4 SOCIO-ECONOMIC ENVIRONMENT 85
4.4.1 Regional Context 85
4.4.2 Local Context 86
5 ANALYSES AND CHARACTERISATION OF ACTIVITY 92
5.1 SITE DELINEATION FOR CHARACTERISATION 92
5.2 WATER AND WASTE MANAGEMENT 92
5.2.1 Process Water 98
5.2.2 Storm Water 98
5.2.3 Groundwater 99
5.2.4 Waste 99
5.3 OPERATIONAL MANAGEMENT 100
5.3.1 Organisational Structure 100
5.3.2 Resources and Competence 100
5.3.3 Education and Training 101
5.3.4 Internal and External Communication 101
5.3.5 Awareness Raising 103
5.4 MONITORING AND CONTROL 103
5.4.1 Surface Water Monitoring 104
5.4.2 Groundwater Monitoring 111
5.4.3 Biomonitoring 114
5.4.4 Waste Monitoring 117
5.5 RISK ASSESSMENT/BEST PRACTICE ASSESSMENT 118
5.6 ISSUES AND RESPONSES FROM PUBLIC CONSULTATION PROCESS 122
5.7 MATTERS REQUIRING ATTENTION/PROBLEM STATEMENT 122
5.8 ASSESSMENT OF LEVEL AND CONFIDENCE OF INFORMATION 122
6 WATER AND WASTE MANAGEMENT 123
6.1 WATER AND WASTE MANAGEMENT PHILOSOPHY 123
6.1.1 Process Water 123
6.1.2 Storm Water 124
6.1.3 Groundwater 124
6.1.4 Waste 124
6.2 STRATEGIES 124
6.2.1 Process Water 124
6.2.2 Storm Water 124
6.2.3 Groundwater 125
6.2.4 Waste 125
6.3 PERFORMANCE OBJECTIVES/GOALS 125
6.4 MEASURES TO ACHIEVE AND SUSTAIN PERFORMANCE OBJECTIVES 126
6.5 OPTION ANALYSIS AND MOTIVATION FOR IMPLEMENTATION OF PREFERRED OPTIONS 126

6.6 LEEUWPAN'S IWWMP ACTION PLAN 126
6.7 CONTROL AND MONITORING 128
6.7.1 Monitoring of Change in Baseline information 128
6.7.2 Audit and Report on Performance Measures 129
7 CONCLUSION 129
7.1 REGULATORY STATUS OF ACTIVITY 129
7.2 STATEMENT OF WATER USE REQUIRING AUTHORISATION 130
7.3 SECTION 27 MOTIVATION 130
7.4 PROPOSED LICENSE CONDITIONS 130
8 REFERENCES 131

LIST OF FIGURES

Figure 1.1 Locality Map 3
Figure 1.2 Locality within the Municipal Boundaries 4
Figure 1.3 Leeuwpan MRA Property Boundaries 6
Figure 2.1 Block OI box-cut 7
Figure 2.2 Mining Right Area and Mining Sections 8
Figure 2.3 Existing Infrastructure at Leeuwpan Mine 14
Figure 2.4: Organisational Structure of Leeuwpan 17
Figure 3.1 Water Use Map 31
Figure 4.1 S-Pan Evaporation at Leeuwpan 40
Figure 4.2 Water Management Area of Leeuwpan 41
Figure 4.3 Identified Wetland Areas 50
Figure 4.4 Map showing wetland units 51
Figure 4.5 Drawdown and recovery curve for borehole WK-BH1 58
Figure 4.6 Drawdown and recovery curve for borehole WK-BH2 59
Figure 4.7 Piper Diagram for Sample WK-BH1 63
Figure 4.8 Expanded Durov diagram of groundwater chemistry regarding March 2020 (Envass, 2020) 65
Figure 4.9 Stiff diagrams of groundwater chemistry regarding September 2020 (Envass, 2020) 66
Figure 4.10 Monitoring Boreholes 67
Figure 4.11 Delineated Sub-catchment with WARMS Boreholes shown on map 75
Figure 4.12 The output per sector (IDP, 2020) 92
Figure 5.1 Water balance process flow diagram – Average monthly conditions 94
Figure 5.2 Water balance process flow diagram – Average annual conditions 95
Figure 5.3 Water balance process flow diagram – Summer conditions 96
Figure 5.4 Water balance process flow diagram – Winter conditions 97
Figure 5.5 Internal Communication 102
Figure 5.6 Receiving Environment Water Sampling Locality Map 106
Figure 5.7 Process Water Sampling Locality Map 107
Figure 5.8 Effluent Water Sampling Locality Map 108
Figure 5.9 Potable Water Sampling Locality Map 109
Figure 5.10 Groundwater Monitoring Boreholes 113
Figure 5.11 Biomonitoring sites (dry season) 115

LIST OF TABLES

Table 0.1 Section 21(a) Water Uses 5

Table 1.1 Contact Details 2
Table 1.2 Farm portions related to existing infrastructure 5
Table 2.1 Mine Schedule 10
Table 2.2 Kenbar/Witklip approved infrastructure from Original EMP 11
Table 2.3 Block OE Activity/Infrastructure approved under MPRDA 11
Table 2.4 OM, OH, OFPAD and OD approved Infrastructure / Activities under the MPRDA 12
Table 2.5 OJ, OL Extension Infrastructure / Activity approved under the MPRDA 12
Table 2.6 OD Infrastructure/Activities 13
Table 2.7 OWM Infrastructure/Activities 13
Table 2.8 Environmental Management at Leeuwpan - Key Responsibilities 18
Table 3.1 Licensed Water Uses (Licence No. 04/B21A/ABCGIJ/429) 20
Table 3.2 Licensed Water Uses (Block OI and OL) (Licence No. 04/B20A/CIJ/4032) 27
Table 3.3: Existing Approved Water Uses (Block OI West) 28
Table 3.4 Existing Lawful Water Uses under Section 21 28
Table 3.5 Section 21(a) Water Use 30
Table 3.6 Leeuwpan's Existing Authorisations 33
Table 4.1 Average minimum and maximum temperatures at Delmas 39
Table 4.2 B20A - Mean Monthly & Annual Precipitation, Evaporation and Runoff 45
Table 4.3 Resource Classes at set out by the DWS 46
Table 4.4 Resource Classes for the Bronkhorstspruit 47
Table 4.5 Wilge River RWQOs 47
Table 4.6 Extent of wetland types identified on site 48
Table 4.7 Aquifer Test Borehole Details 57
Table 4.8 Aquifer Test Results 59
Table 4.9 Recommended Pumping Schedule 60
Table 4.10 Groundwater Laboratory Results 61
Table 4.11 Quaternary Catchment Details for Catchment B20A 68
Table 4.12 WARMS Borehole Details for Quaternary Catchment B20A and B20B 69
Table 4.13 Groundwater Balance Calculation for quaternary catchment B20A containing the DDC 72
Table 4.14 Groundwater Balance Calculation for quaternary catchment B20B containing the DDC 73
Table 4.15 Guide for determining the level of stress of a groundwater resource unit 74
Table 4.16 Parameters assigned to various lithologies in the analytical equations 78
Table 4.17 Radius of Influence Calculations 79
Table 4.18 Thiem Formula drawdown calculations for WK-BH1 and WK-BH2 80
Table 4.19 Equation 4 and 5 Calculations 81
Table 4.20 Equation 6 Calculations 82
Table 4.21 Equation 7 and 8 Calculations 82
Table 4.22 Hantush-Jacob Formula drawdown calculations for WK-BH1 83
Table 4.23 Hantush-Jacob Formula drawdown calculations for WK-BH2 83
Table 4.24 Head of household by sex (adult: above 18 years old) (Stats SA, 2016) 87
Table 5.1 Summary of Components monitoring for Leeuwpan 103
Table 5.2 Leeuwpan Surface Water Sampling Points 105
Table 5.3 Water quality parameters for Leeuwpan Coal Mine 110
Table 5.4 Water Level Monitoring Plan for WK-BH1 111
Table 5.5 Groundwater Monitoring (Envass, 2020) 112
Table 5.6 Severity 119
Table 5.7 Spatial Scale - How big is the area that the aspect is impacting on? 119
Table 5.8 Duration 119
Table 5.9 Frequency of the activity - How often do you do the specific activity? 119
Table 5.10 Frequency of the incident/impact - How often does the activity impact the environment? 119
Table 5.11 Legal issues - How is the activity governed by legislation? 119
Table 5.12 Detection - How quickly/easily can the impacts/risks of the activity be detected on the environment, people and property? 120

Table 5.13 Impact Ratings 120
Table 5.14 Impacts and Management Measures 121
Table 6.1 Leeuwpan's IWWMP Action Plan 126

LIST OF ANNEXURES

Annexure A Section 27 Motivation
Annexure B Hydrogeological Assessment
Annexure C Monthly Water Quality Report
Annexure D Biannual Aquatic Biomonitoring Assessment
Annexure E Water Balance
Annexure F Current Licenses Issued
Annexure G Wetland Delineation Assessment
Annexure H Quarterly Water Quality Report

1 INTRODUCTION

1.1 Activity Background

Exxaro Leeuwpan Coal Mine (Leeuwpan) began as an Iscor Mine in 1991, doing extensive exploration with the first box-cut commencing in 1992. Leeuwpan is currently an operational mine and became known as Exxaro Leeuwpan Coal Mine in 2007. Leeuwpan is located 10 kilometres (km) south east of Delmas, in the Victor Khanye Local Municipality. The mine falls within the Nkangala District Municipality in the Mpumalanga Province.

Leeuwpan is an operational coal mine that has been operating in line with several approved Environmental Management Plans (EMP's). These EMP's were submitted to and approved by the Department of Mineral resources (DMR). As a result of the authorisations issued, Leeuwpan is a lawful mining operation in terms of the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA).

Leeuwpan is situated in the upper reaches of the Bronkhorstspruit catchment in quaternary catchment B20A. In compliance with the National Water Act, 1998 (Act No. 36 of 1998) (NWA), the Department of Water and Sanitation (DWS) [now the Department of Human Settlements, Water and Sanitation (DHSWS)] issued an Integrated Water Use Licence (IWUL) to Leeuwpan (Licence No. 04/B21A/ABCGIJ/429) on the 25th March 2011.

Following a meeting with the DHSWS, the DHSWS indicated that Leeuwpan requires authorisation in the form of a Water Use License (WUL) for the abstraction of water from the Witklip borehole (Witklip Borehole 1) for operations at the Leeuwpan Coal Mine. This borehole was not licensed as part of the authorisations previously issued and was previously been listed as an Existing Lawful Water Use (ELWU) in previous reports. DHSWS have however, requested that an application be made to license this abstraction. In addition, a second borehole (Witklip Borehole 2) is being applied for as a backup supply borehole to supplement Witklip borehole 1 water if water cannot be abstracted from it. Abstraction of water from the two boreholes triggers a water use in terms of Section 21(a) 'taking water from a water resource' of the NWA. The authorisation process requires that an application in the form of a Water Use License Application (WULA) be undertaken.

GCS Water and Environment (Pty) Ltd (GCS) were appointed to undertake the WULA process in order to authorise the required abstractions. This report serves as the technical application report pertaining to the Section 21(a) WULA.

1.2 Contact Details

The contact details of the mine and the consultant compiling this WULA update can be seen in Table 1.1.

Table 1.1 Contact Details

Contact Details of the Applicant	
Name of the Company	Exxaro Resources Limited
Name of the Mine	Leeuwpan Coal Mine
Physical Address	R50 Delmas
Postal Address	PO Box 9229 Pretoria 0001
Telephone	(011) 441-6800
Fax Number	(011) 268 6734
Contact Person	Lucy Mogakane (Leeuwpan Mine Environmental Specialist) Lucy.mogakane@exxaro.com
Contact Details of the Environmental Consultant	
Name of the Company	GCS Water and Environment (Pty) Ltd
Physical Address	63 Wessel Road, Rivonia, 2128
Postal Address	P.O. Box 2597, Rivonia, 2128
Telephone	(011) 803 5726
Fax Number	(011) 803 5745
Contact Person	Shayna-Ann Cuthbertson (Water Use Authorisation Consultant) shaynac@gcs-sa.biz Kate Cain (Water Use Authorisation Unit Manager) kate@gcs-sa.biz

1.3 Regional Setting and Location of Activity

The Leeuwpan Mining Right Area (MRA) is located approximately 10km south east of Delmas. The MRA is adjacent to Ferroglobe (formerly Thaba Chueu) Silica Mine and Stuart Coal. Refer to Figure 1.1 for the map indicating the location of the project area.

1.3.1 Magisterial District and Local Municipality

The project area is situated within the Nkangala District Municipality in the Victor Khanye Local Municipality. The municipal boundaries are indicated on Figure 1.2.

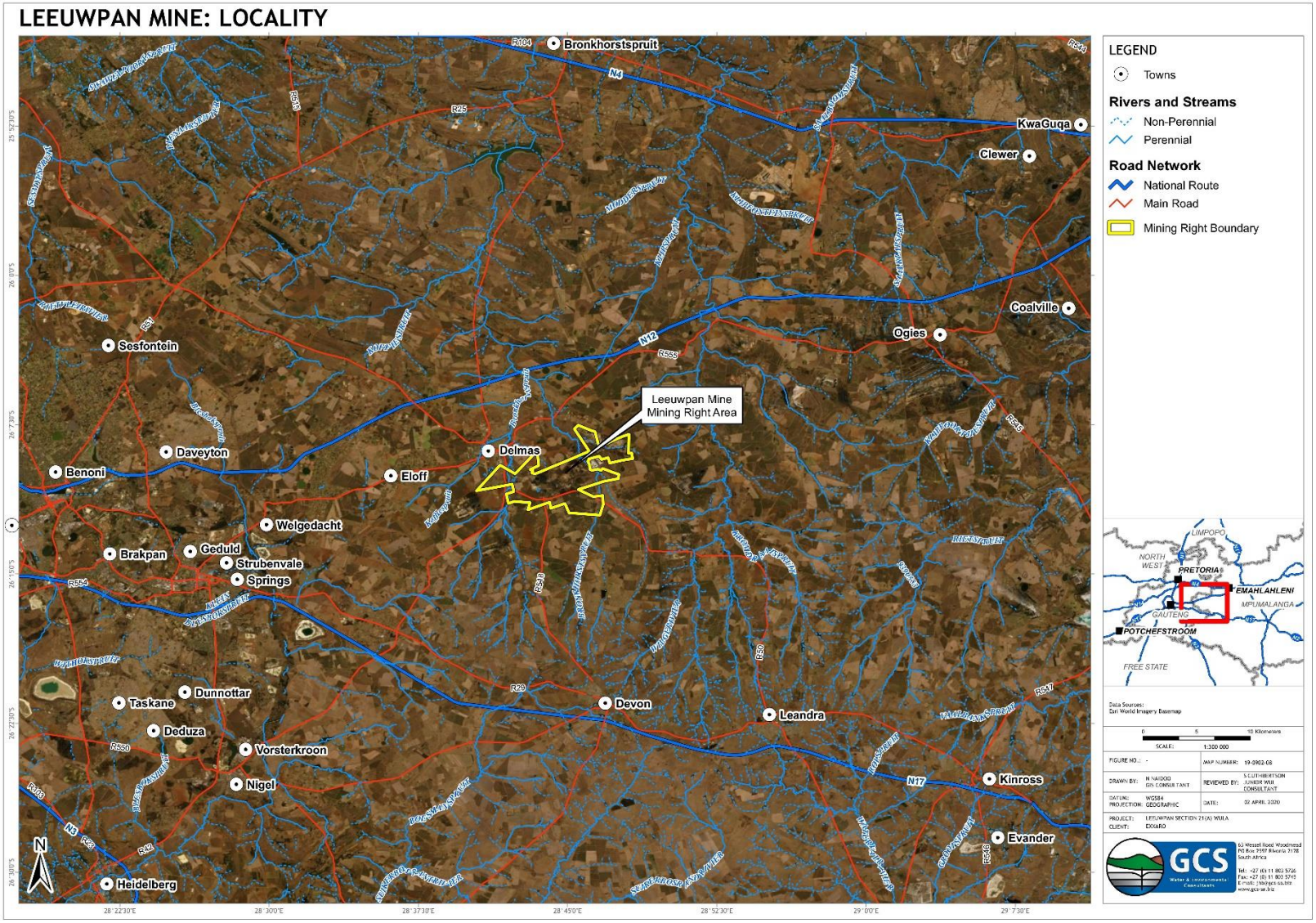


Figure 1.1 Locality Map

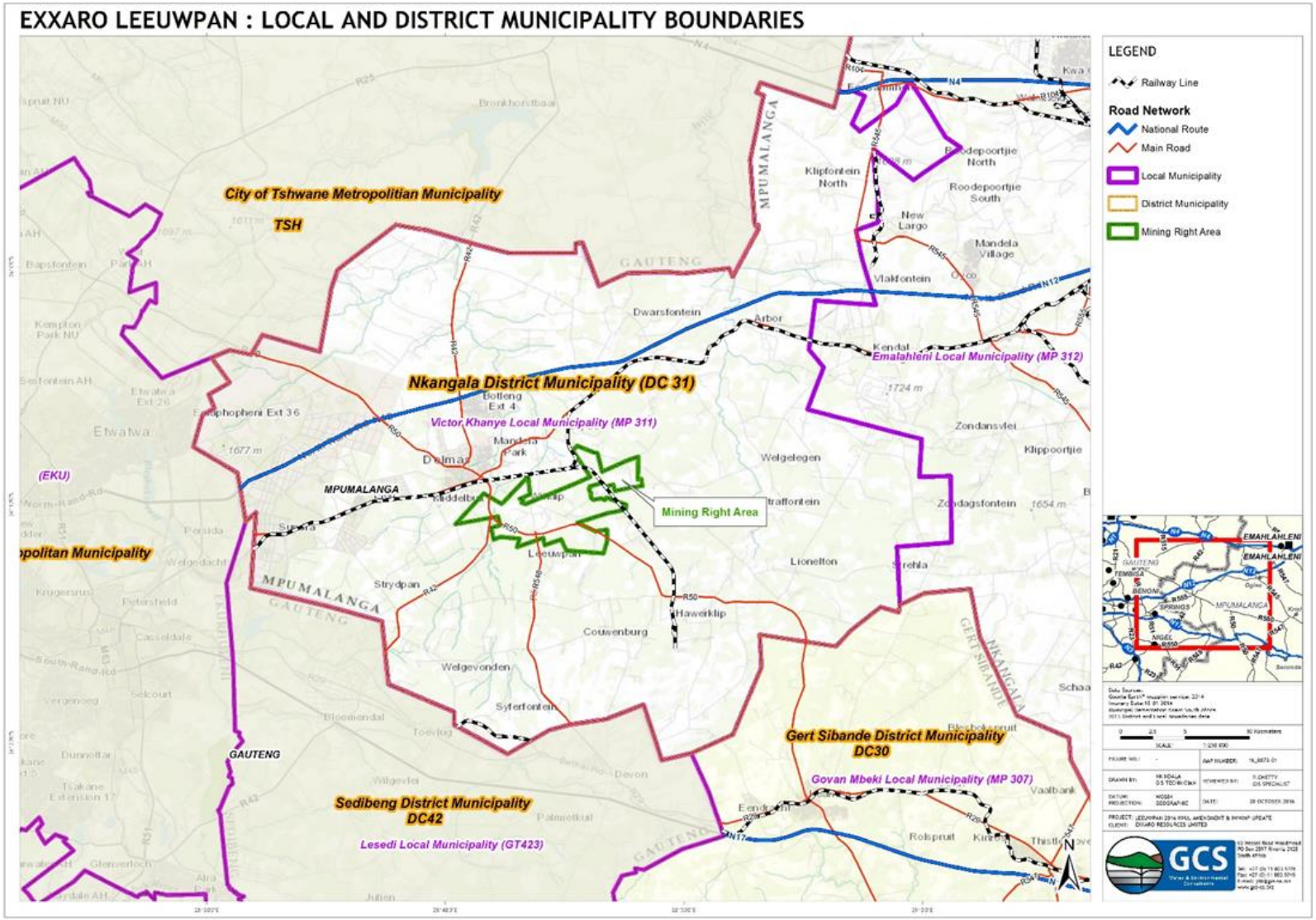


Figure 1.2 Locality within the Municipal Boundaries

1.4 Property Description

The Mining Right Area (MRA) comprises eight (8) farms, namely Kenbar 257 IR, Leeuwpan 246 IR, Moabsvelden 248 IR, Weltevreden 227 IR, Witklip 229 IR, Witklip 232 IR, Wolvenfontein 244 IR and Rietkuil 249. Nine mineral resource blocks have been mined or are in the process of being mined.

Three Mineral resource blocks, located on Rietkuil 249 IR, Moabsvelden 248 IR and Wolvenfontein 244 IR are currently being mined. The property details for the MRA were obtained from the government deeds website (www.deeds.gov.za). The majority of the surface rights are privately owned.

Current infrastructure is located on the following farm portions (Table 1.2). The property boundaries in relation to the MRA are provided in Figure 1.3. The highlighted detail is relevant to this application as it is the property on which the boreholes are located.

Table 1.2 Farm portions related to existing infrastructure

SG Number	Farm	Portion	Owner detail
T0IR00000000025700000	KENBAR 257	Portion 0	Exxaro Coal Pty Ltd
T0IR00000000024600003	LEEUWPAN 246	Portion 3	Exxaro Coal Pty Ltd
T0IR00000000024800001	MOABSVELDEN 248	Portion 01	Gouws Louis
T0IR00000000024800002	MOABSVELDEN 248	Portion 02	Exxaro Coal Pty Ltd
T0IR00000000024800003	MOABSVELDEN 248	Portion 03	Exxaro Coal Pty Ltd
T0IR00000000024800004	MOABSVELDEN 248	Portion 04	Phillem Beleggings Pty Ltd
T0IR00000000024800005	MOABSVELDEN 248	Portion 05	Exxaro Coal Pty Ltd
T0IR00000000024800006	MOABSVELDEN 248	Portion 06	Exxaro Coal Pty Ltd
T0IR00000000024800010	MOABSVELDEN 248	Portion 10	Exxaro Coal Pty Ltd
T0IR00000000024800012	MOABSVELDEN 248	Portion 12	Exxaro Coal Pty Ltd
T0IR00000000024800013	MOABSVELDEN 248	Portion 13	Exxaro Coal Pty Ltd
T0IR00000000024800016	MOABSVELDEN 248	Portion 16	Exxaro Coal Pty Ltd
T0IR00000000024800027	MOABSVELDEN 248	Portion 27	Transnet Ltd
T0IR00000000024800030	MOABSVELDEN 248	Portion 30	Transnet Ltd
T0IR00000000024800032	MOABSVELDEN 248	Portion 32	Transnet Ltd
T0IR00000000022700007	WELTEVREDEN 227	Portion 07	Exxaro Coal Pty Ltd
T0IR00000000022700037	WELTEVREDEN 227	Portion 37	Transnet Ltd
T0IR00000000022900004	WITKLIP 229	Portion 04	Exxaro Coal Pty Ltd
T0IR00000000022900006	WITKLIP 229	Portion 06	Hendrik Schoeman & Seuns Pty Ltd
T0IR00000000023200113	WITKLIP 232	Portion 113	Eskom Holdings Ltd
T0IR00000000023200016	WITKLIP 232	Portion 16	Hendrik Schoeman & Seuns Pty Ltd
*T0IR00000000024400003	WOLVENFONTEIN 244	Portion 03 (now 8)	Endorsement: Exxaro Coal Pty Ltd

*Portion 3 of the farm Wolvenfontein 244 IR no longer exists as it was subdivided into portion 4, portion 5 and the remaining extent (RE). The RE of Portion 3 was in turn consolidated with Portion 7 of the farm Wolvenfontein 244 IR to form Portion 8 of the farm Wolvenfontein 244 IR. Exxaro Coal (Pty) Ltd is the registered owner of Portion 8 (T9659/2002).

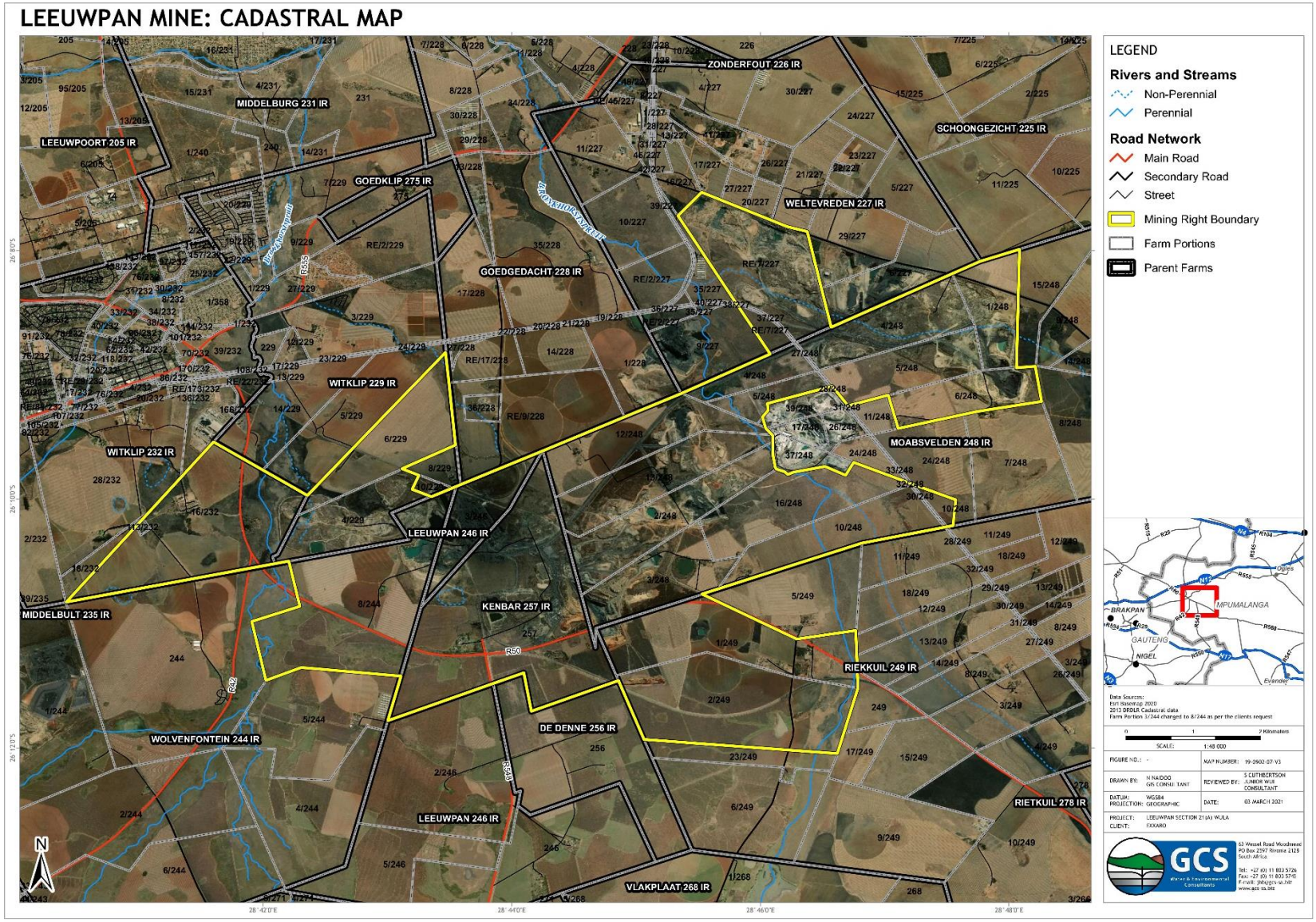


Figure 1.3 Leeuwpan MRA Property Boundaries

2 CONCEPTUALISATION OF THE ACTIVITY

2.1 Description of the Activity

2.1.1 Existing Operations

Leeuwpan is an existing coal mining operation with existing infrastructure associated with the following mining areas:

- Block OMW;
- Weltevreden;
- Block OL; and
- Block OI and OI West

Opencast mining started on the farm Witklip in 1994. According to the mine's personnel, available coal reserves that are being mined include Blocks OI, OI West (Figure 2.1), OL, OMW and Weltevreden. Weltevreden, Moabsvelden (MBV), Block OJ and OL are earmarked for void closure rehabilitation. Block OJ is currently being backfilled and is expected to be finalised by end of 2019. The areas that are earmarked for shaping and grassing include Weltevreden, Moabsvelden, ODS, OG, OJ, Witklip and Discard Workshop. The approved, existing and proposed mining sections in relation to the MRA of Leeuwpan are presented in Figure 2.2.



Figure 2.1 Block OI box-cut

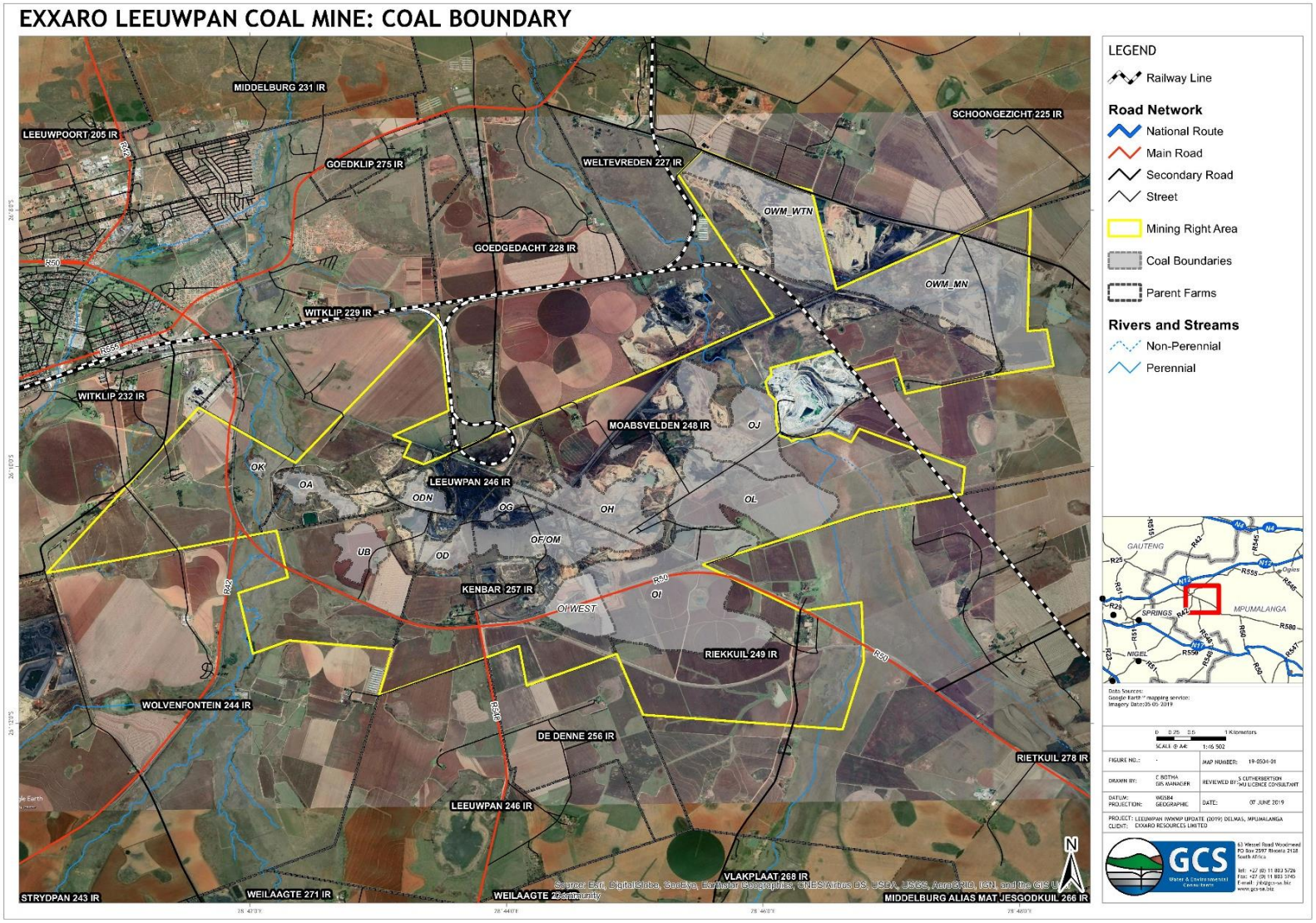


Figure 2.2 Mining Right Area and Mining Sections

2.2 Extent of the Activity

All activities relating to the mining activities take place within the approved MRA of Leeuwpan. The operations at Leeuwpan Coal spread over 4 256ha, of which the majority is comprised of mining areas (operational, rehabilitated and proposed mining areas), such as box-cuts, dams and stockpiled material. The remaining areas comprise of the Beneficiation Plant, as well as workshops and administration blocks which belong to both Exxaro Resources Limited as well as the appointed contractors.

2.3 Key Activity Related Processes and Product

2.3.1 Mining Method

Opencast coal mining techniques are used at Leeuwpan Mine to produce steam and metallurgical grade coal. Coal is selectively mined using a modified terrace method with a fleet of 100 ton class hydraulic excavators and 40 ton articulated dump trucks. The reserves are mined using the drilling, blasting, loading and hauling with truck and shovel, excavator and fleet methods. Once the coal has been mined it is transported to the plant area for processing.

2.3.2 Mineral Processing

Currently the coal distribution consists of a crusher plant and a washer to refine the coal by means of a wet process. A Final Phase Coal Processing Plant is used for washing and sorting. The Interim Phase processing plant has been dismantled and removed from the site. The final phase processing plant consists of two Dense Medium Separation (DMS) plants (operated by Frazer Alexander and one by Exxaro) and crush and stack plant (operated by B&E).

The Processing Plant area consists of various areas, such as the:

- Beneficiation plant;
- Run of Mine (ROM) Stockpiles;
- Crush and screening plant;
- Product stockpiles;
- Filter press;
- Pollution Control Dams (PCD);
- Laboratories; and
- Plant offices and control room.

2.3.2.1 Existing beneficiation plant:

The Beneficiation Plant consists of a Crushing and Washing Plant. Process water, consisting of groundwater ingress into the pits and make-up water from boreholes, is used at the Beneficiation Plant.

Process water is used on a continuous basis and is proportional to the amount of coal that is being washed per day. No significant daily fluctuations exist in the use of water on the mine. The Beneficiation Plant operates 24 hours a day for 313 days per year.

2.3.3 Product

The niche market for the mine is the production of low volatile coal. From the plant the processed coal is transported via conveyors to the load out area siding. The final coal product is transported by means of railroad to the different work centres or via road transport to other markets such as Eskom. Road transport is handled by means of a weighbridge.

2.4 Activity Life Description

Due to the approval and mining of Block OI and OI West, the Life of Mine (LOM) will be extended by an extra 14 years from 2018. The life of mine has been determined by the availability of the coal resource that can be mined within the mining right area. Refer to Table 2.1 for the life of mine schedule.

Table 2.1 Mine Schedule

Mine Block / Pit	Mining Dates		Current Status	Scheduled Life of Mine
	Start Date	End Date		
OA Witklip	1996	Mar-2005	Decommissioned	-
ODN	May-2008	Sep-2010	Decommissioned	-
OE Midklip	1998	Jun-1999	Decommissioned	-
OF Kenbar	1992	Mar-2004	Decommissioned	-
ODS	Mar-2004	2014	Decommissioned	-
OM	Dec-1999	2014	Decommissioned	-
OH	Sep-2002	2016	Decommissioned	-
OG	Sep-2006	Jul-2011	Decommissioned	-
OJ	Oct-2008	2018	Decommissioned	-
OWM_WTN	Sep-2011	2017	Decommissioned	-
OWM_MN	Dec-2008	-	In Operation	2020
OL	2018	-	In Operation	2024
OI	2018	-	In Operation	2030
UB	-	-	Planned future mining	2024 - 2029

2.5 Activity Infrastructure Description

As previously stated, Leeuwpan mine is an operational mine that has been operating in line with several approved Environmental Management Plans (EMPs). Infrastructure approved under the Mineral and Petroleum Resources Development Act, 2002 (Act No. 28 of 2002) (MPRDA) at Leeuwpan is detailed in the sections that follow for each of the mining areas. Each table indicates what infrastructure still exists and what has been removed. Figure 2.3 shows the existing infrastructure of Leeuwpan Coal Mine.

2.5.1 Kenbar and Witklip

Table 2.2 indicates infrastructure and facilities approved under the MPRDA associated with the original EMP for Kenbar and Witklip.

Table 2.2 Kenbar/Witklip approved infrastructure from Original EMP

Activity / structure	Still existing
Discharge silo and conveyor band across the Delmas – Leandra road	No
Equipment workshop	Yes
Coal mixing bed and off-load facilities	Yes
Railroad of ± 3 km for the transport of coal from Leeuwpan	Yes
Weighbridge for the road transport	Yes
Ablution block and administration offices	Yes
A linking road with the R 50 route (between Delmas and Leandra) including security buildings	No
A linking road with the P 36-2 route between Delmas and Devon	No
Pit water dam and silt dams	No
Evaporation ponds	Yes
Additional storm water control measures (berms)	Yes
Electricity supply network	Yes
Closed water network for process water	Yes
Potable water supply via pipeline	Yes
Sewerage infrastructure	Yes
River diversion	Yes
Mining of Kenbar and Witklip sections	Yes – not operational

2.5.2 Block OE

A number of changes with regards to environmental management, particularly with respect to water management, came about at Leeuwpan Coal Mine during 1997. Approved activities and infrastructure under the MPRDA are indicated in Table 2.3.

Table 2.3 Block OE Activity/Infrastructure approved under MPRDA

Activity / structure	Still existing
Discharge of excess water into an unnamed tributary of the Bronkhorstspruit	No
Demolition of old plant (interim phase plant)	No
New plant (final phase plant)	Yes
Opencast block (Block OE)	Yes – not operational
River diversion	Yes

2.5.3 Block OD, OFPAD, OH and OM

The mining of Block OM, Block OH, Block OFPAD and Block OD involved the extension of the existing mining operation and Table 2.4 indicates the activities / infrastructure approved under the MPRDA that were added during the process.

Table 2.4 OM, OH, OFPAD and OD approved Infrastructure / Activities under the MPRDA

Activity / structure	Still existing
Extension of existing haul roads to Block OM, Block OH as well as Block OFPAD and Block OD	Yes
Relocation of the 11 kV powerlines and associated mini substations	Yes
Clean and dirty water systems around the mining area of Block OM, Block OH, Block OFPAD and Block OD	Yes
Road diversions and associated infrastructure	Yes
Mining activities	Yes

2.5.4 Block OJ and OL

The Addendum 4 EMP was compiled for the extension of Block OJ and OL on the Farm Moabsvelden 248 IR. Infrastructure and activities that was approved under the MPRDA in the proposed extension are shown in Table 2.5. As mentioned previously, it was agreed in consultation with Mpumalanga Department of Land Administration (MDALA), since all activities are directly related to mining, that it was not be necessary to obtain authorisation in terms of the Environmental Impact Assessment (EIA) Regulations in terms of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA). Block OJ is currently being backfilled and is expected to be finalised by end of 2019.

Table 2.5 OJ, OL Extension Infrastructure / Activity approved under the MPRDA

Activity / structure	Still existing
Infrastructure in the one in ten year flood line of a river or stream, or within 32 meters of the bank of a river or stream	Yes
The construction of a road that is wider than 4m	Yes
Development activity, including associated structure or infrastructure.	Yes
Mining of mining blocks	Yes

2.5.5 Block OD, OI and OWM

In 2006 an EIA/EMP was compiled for Kumba Coal for the mining of an extension of the existing Block OD on the farm Wolvenfontein 244 IR; and Block OI to be mined underground on the farm Rietkuil 249 IR.

Block OI however, has not been mined yet and only a box-cut has been established. Table 2.6 shows the infrastructure and activities approved under the MPRDA for the OD mining area.

As mentioned previously it was agreed in consultation with MDALA, since all activities are directly related to mining, that it was not be necessary to obtain authorisation in terms of the EIA Regulations.

Table 2.6 OD Infrastructure/Activities

Activity / structure	Still existing
Topsoil and overburden stockpiles	Yes
RoM stockpile	Yes
Storm water diversion channels	Yes
Expansion of existing haul roads	Yes
Pollution water management system	Yes
Water supply system	Yes
Ablution facilities	Yes
Diesel fuel tank	Yes
Workshop	Yes
Site offices	Yes
Explosives magazine	Yes
Mining of OD	Yes

In 2006 an EIA/EMP was also compiled for the mining of Block OWM on the farms Weltevreden 227 IR and Moabsvelden 248 IR. Table 2.7 shows the approved infrastructure (under the MPRDA) associated with the proposed mining of Block OWM.

Table 2.7 OWM Infrastructure/Activities

Activity / structure	Still existing
Topsoil and overburden stockpiles	Yes
ROM stockpile	Yes
Water pollution management system	Yes
Storm water diversion measures, including the proposed stream alteration	Yes
Water supply system	Yes
Haul road and access roads	Yes
Portable ablution facilities	Yes
Diesel fuel tank	Yes
Temporary workshop	Yes
Portable site office	Yes
Explosives magazine	Yes
Mining of OWM	Yes

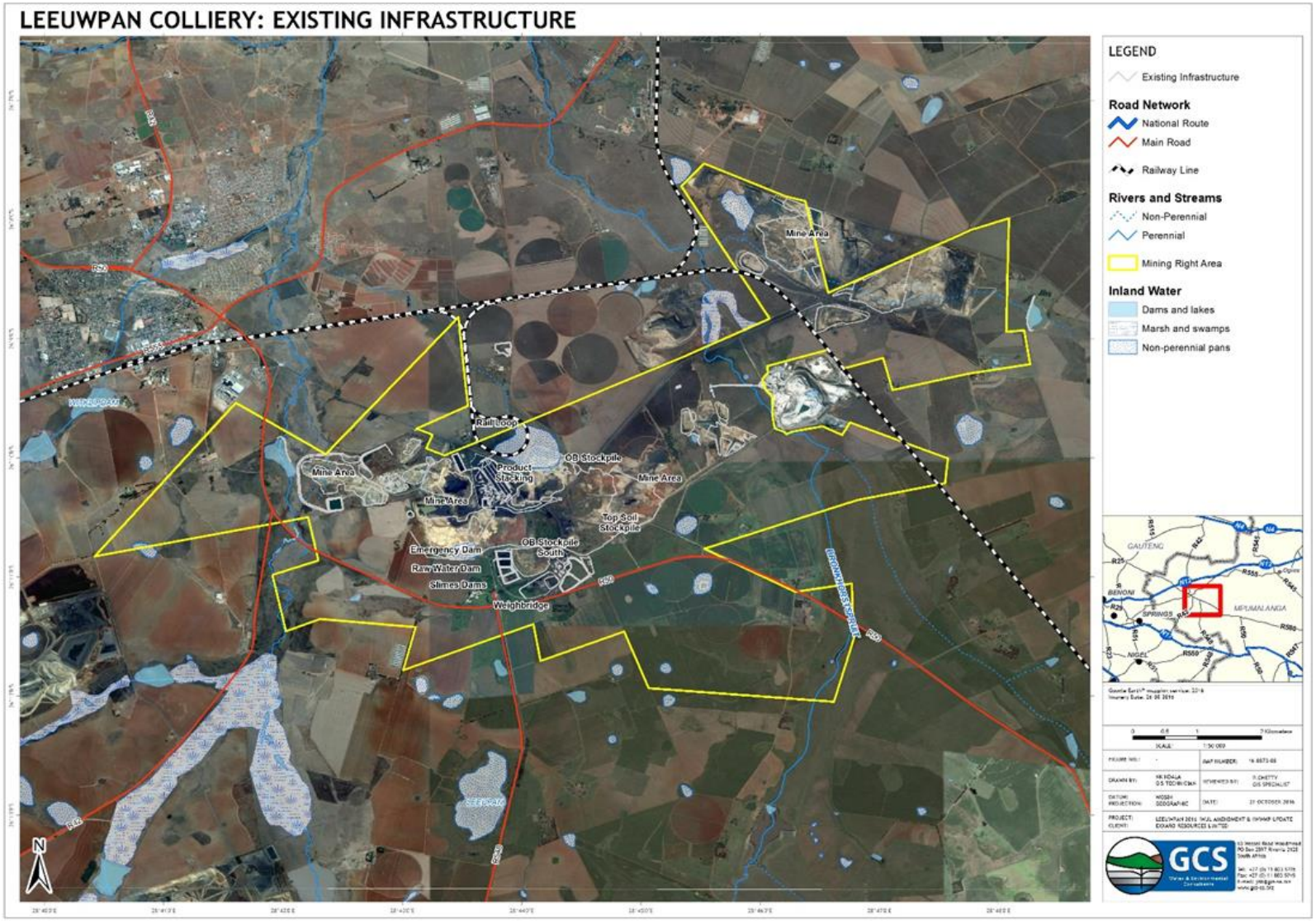


Figure 2.3 Existing Infrastructure at Leeuwpan Mine

2.6 Key Water Uses and Waste Streams

2.6.1 Key Water Uses

Leeuwpan was issued with an IWUL on the 25th March 2011 (Licence No. 04/B21A/ABCGIJ/429). The IWUL was issued for various water uses being undertaken on site in terms of Section 21 of the NWA. The license was issued for the following water uses:

- Section 21(a) – Taking of water from a water resource;
- Section 21(b) – Storing of Water;
- Section 21(c) – Impeding or diverting the flow of water in a watercourse;
- Section 21(g) – Disposing of waste in a manner which may detrimentally impact on a water resource;
- Section 21(i) – Altering the bed, banks, course or characteristics of a watercourse; and
- Section 21(j) – Removing, discharging or disposing of water found underground

An amendment to the IWUL for Leeuwpan was also issued in terms of Section 50 and Section 158 of the NWA on the 18th December 2015. This amendment was issued to amend / correct water uses licensed as part of the IWUL issued on the 25th March 2011. The following water uses in terms of Section 21 of the NWA were amended:

- Section 21(a) – Taking of water from a water resource;
- Section 21(c) – Impeding or diverting the flow of water in a watercourse;
- Section 21(g) – Disposing of waste in a manner which may detrimentally impact on a water resource;
- Section 21(i) – Altering the bed, banks, course or characteristics of a watercourse; and
- Section 21(j) – Removing, discharging or disposing of water found underground

A separate Integrated Water Use Licence Application (IWULA) was submitted to authorise water uses associated with the mining of the Block OI and OL Expansion. The IWUL was awarded to Leeuwpan (Licence No. 04/B20A/CIJ/4032) on the 18th December 2015. The IWUL was issued for various water uses required for the expansion project in terms of Section 21 of the NWA. The license was issued for the following water uses:

- Section 21(a) – Taking of water from a water resource;
- Section 21(c) – Impeding or diverting the flow of water in a watercourse;
- Section 21(g) – Disposing of waste in a manner which may detrimentally impact on a water resource;
- Section 21(i) – Altering the bed, banks, course or characteristics of a watercourse; and

- Section 21(j) – Removing, discharging or disposing of water found underground.

An additional application was submitted to expand mining Block OI to include the area where planned infrastructure would have originally been located. This expansion area is referred to as OI West. Water uses for this expansion are triggered in terms of Section 21(c) and (i) of the NWA. The IWUL was awarded to Leeuwpan (Licence No. 06/B20A/CI/9521) on the 4th March 2020. The license was issued for the following water uses:

- Section 21(c) – Impeding or diverting the flow of water in a watercourse; and
- Section 21(i) – Altering the bed, banks, course or characteristics of a watercourse.

Refer to Section 3 for detailed information regarding the water uses for Leeuwpan Mine. The two boreholes being applied for as part of this application is considered a key water use for the operation of Leeuwpan in terms of water supply.

2.6.2 Key Waste Streams

The waste streams associated with the Leeuwpan mining operation include coal discard, polluted mine water, sewage, hydrocarbon wastes, and general waste. These include:

- Mine Residue Deposit (MRD), which includes:
    - Carbon-carrying shales;
    - Plant residue; and
    - Fine coal recovered from the slimes dams.
- Polluted mine water, which includes the various pollution control dams (PCDs);
- Hydrocarbon waste such as oil, diesel & grease; and
- General waste which is limited to domestic and commercial waste.

Refer to Section 5.2.4 of this report for more details pertaining to the waste generated on site and the management thereof.

2.7 Organisational Structure of the Activity

Please refer to Figure 2.4 for the Organisational Structure relating to Leeuwpan Mine.



Figure 2.4: Organisational Structure of Leeuwpan

Table 2.8 provides details pertaining to the responsibilities in terms of environmental management appointments at Leeuwpan Mine.

Table 2.8 Environmental Management at Leeuwpan - Key Responsibilities

Responsible Person	Function and Responsibility
Mine Manager	Reports directly to the EXCO of Exxaro Resources and apart from his production responsibilities, is also responsible to ensure that the Safety, Health and Environmental (SHE) management system for Leeuwpan Coal is developed, implemented and maintained
Manager Mining	Reports directly to the Mine Manager of Leeuwpan Coal, and shall be responsible to co-ordinate coal extraction activities and to maintain the mining SHE system for Leeuwpan Coal, the training of personnel and the co-ordination of all administrative activities
Resident Engineer	Reports directly to the Mine Manager of Leeuwpan Coal and shall be responsible to co-ordinate the engineering activities and to maintain the engineering SHE system for Leeuwpan Coal, the training of personnel and the co-ordination of all administrative activities
Plant Manager	Reports directly to the Mine Manager of Leeuwpan Coal and shall be responsible to co-ordinate the beneficiation activities and to maintain the plant SHE system for Leeuwpan Coal, the training of personnel and the co-ordination of all administrative activities
Sustainability Manager	Reports to the Mine Manager and is responsible to ensure that Sustainability issues are promoted throughout the mine on a continuous basis. The Sustainability Manager must report to management on accident and incidents to measure the SHE performance at Leeuwpan Coal.
Chief Safety Officer	Reports directly to the SHE Manager and is responsible to ensure that safety and health issues are promoted throughout the mine on a continuous basis including recommendations for improvements. Part of his duties is then also pertaining to environmental issues such as handling of water around the pits as this directly affects the safety of employees.
Environmental Specialist	Reports to the Sustainability Manager and is responsible to ensure that environmental issues are promoted throughout the mine on a continuous basis including recommendations for improvement.
Human Resource Manager	Reports directly to the Mine Manager of Leeuwpan Coal and shall be responsible to co-ordinate the Human Resource Management activities for Leeuwpan Coal.
All other employees	All employees have the responsibility to act in such a manner that ensures Sustainability incidents and pollution is prevented and when they occur that such incidents are immediately reported to management.

2.8 Business and Corporate Policies

2.8.1 Safety, Health and Environmental Policy

Leeuwpan implements the following health, safety and environmental policies:

- Environmental Policy Statement: Commits Leeuwpan to conducting its business in a manner that protects human health, natural resources and the environment. The company will cooperate with communities and regulatory agencies to implement sound management practices that ensure environmental protection whilst mining. Regarding legacy mining impacts, the company commits to identifying remediation

activities and implementing such plans in a manner that is credible and transparent; and

- Occupational Health and Safety Policy: Provides for the protection of all Leeuwpan employees and those who are not employees but who are directly affected by Leeuwpan's activities.

2.8.2 Objectives and Strategies

The **objectives of the Safety and Health** management system are to:

- Have an injury free working environment combined with zero tolerance for non-compliance or unsafe behaviour;
- Minimise major occupational risk in the work environment in order to eliminate occupational illness and disability; and
- Maintain high standards in respect to all of Leeuwpan's operations.

The **Environmental objectives** are to ensure sustainable exploitation of natural resources through dedicated programmes focusing on water resource management, air quality management and biodiversity management steered by the Environmental Management division.

The following strategically important water resource management objectives could be identified:

- Water Resource Protection;
- Water Use Management;
- Water Conservation (WC) and Water Demand Management (WDM); and
- Monitoring and Information Management.

It is necessary to consider that water impacts might increase over time. This entails that the cost for operational and closure water management will increase, as well as an increased risk to the environment (social, ecologic and economic) in the future.

The framework in which Leeuwpan proposes water management makes provision for the following requirements:

- Treatment technologies are expensive and will have associated long-term operating and maintenance costs;
- Industry needs to be profitable with a return on investment to shareholders;

- The operation has the responsibility to manage risks associated with water impacts. The applicant will be in a position to manage long-term liabilities and risks associated with post closure;
- Leeuwpan would have the liability for post closure environmental impacts (including water impacts); and
- It should be recognised that the cost to manage water is time dependent and intervention during the operational water management phase would reduce long-term liability.

3 REGULATORY WATER AND WASTE MANAGEMENT FRAMEWORK

3.1 Summary of all Water Uses

Refer to Table 3.1 for all of the licenced water uses as per the first issued IWUL (Licence No. 04/B21A/ABCGIJ/429) and its associated Amendment issued in 2015 as well as Table 3.1 Table 3.2 for all of the licenced water uses as per the expansion IWUL (Licence No. 04/B20A/CIJ/4032) issued. In addition, refer to Table 3.3 for all of the licenced water uses for Block OI West.

Table 3.1 Licensed Water Uses (Licence No. 04/B21A/ABCGIJ/429)

Water Uses - Leeuwpan Mine (04/B21A/ABCGIJ/429) Including 18th December 2015 Amendments				
Section 21(a)	**Site Name**	**Co-ordinates**	**Property**	**Volume Licenced**
Taking of water from a Borehole	Borehole	26°55'07.7"S 29°36'04.0"E	Kenbar 257 IR	68 400m³
Abstraction of waste water from Block OD	Block OD	26°10'41.6"S 28°43'26.3"E	Kenbar 257 IR	226 992m³/a
Abstraction of waste water from Block OM	Block OM	S26°10'24.2" E28°44'58.4"	Kenbar 257 IR	20 000m³/a
Abstraction of waste water from Block OH	Block OH	S26°10'24.2" E28°44'58.4"	Kenbar 257 IR	26 400m³/a
Abstraction of waste water from Block OJ	Block OJ	S26°09'49.2" E28°45'45.2"	Moabsvelden 248 IR	292 000m³/a
Abstraction of waste water from Block OWM	Block OWM	S26°09'49.2" E28°45'45.2"	Moabsvelden 248 IR	31 880m³/a
Section 21(b)	**Site Name**	**Co-ordinates**	**Property**	**Capacity m³**
Low Lying Area 2: Storage capacity varying circular unlined	Low Lying Area 2	26°11'09.8"S 28°42'33.1"E	Wolvenfontein 244 IR	188 000
Section 21(c) and (i)	**Property**			

Water Uses - Leeuwpan Mine (04/B21A/ABCGIJ/429) Including 18th December 2015 Amendments				
Block OWM River diversion – Weltevreden tributary of the Bronkhorstspruit	Moabsvelden 248 IR & Weltevreden 227 IR			
Section 21(g)	**Site Name**	**Co-ordinates**	**Property**	**Capacity / Size / Area/ Volume Licenced (m^3/a)**
Dirty runoff and process water used for dust suppression	Dust Suppression	26°10'45.4"S 28°43'58.0"E	Kenbar 257 IR	6 552
Disposing of waste into the pollution control dam in a manner which may detrimentally impact on a water resource - Septic tank (all these tanks are transported via honey sucker to the $7m^3$ STP located at the mining green area	Septic Tank 1	26°10'53.1"S 28°44'20.4"E	Kenbar 257 IR	$10m^3$
Disposing of waste into the pollution control dam in a manner which may detrimentally impact on a water resource - Septic tank (all these tanks are transported via honey sucker to the $7m^3$ STP located at the mining green area	Septic Tank 2	26°10'54.8"S 28°44'17.5"E	Kenbar 257 IR	$10m^3$
Disposing of waste into the pollution control dam in a manner which may detrimentally impact on a water resource - Septic tank (all these tanks are transported via honey sucker to the $7m^3$ STP located at the mining green area	Septic Tank 3	26°10'55.4"S 28°44'18.5"E	Kenbar 257 IR	$10m^3$
Disposing of waste into the pollution control dam in a manner which may detrimentally impact on a water resource - Septic tank (all these tanks are transported via honey sucker to the $7m^3$ STP located at the mining green area	Septic Tank 4	26°10'56.2"S 28°44'16.9"E	Kenbar 257 IR	$10m^3$
Disposing of waste into the pollution control dam in a manner which may detrimentally impact on a water resource - Septic tank (all these tanks are	Septic Tank 5	26°10'57.7"S 28°44'20.2"E	Kenbar 257 IR	$10m^3$

Water Uses - Leeuwpan Mine (04/B21A/ABCGIJ/429) Including 18th December 2015 Amendments				
transported via honey sucker to the 7m³ STP located at the mining green area				
Disposing of waste into the pollution control dam in a manner which may detrimentally impact on a water resource - Septic tank (all these tanks are transported via honey sucker to the 7m³ STP located at the mining green area	Septic Tank 6	26°11'09.2"S 28°43'46.4"E	Kenbar 257 IR	10m³
Disposing of waste into the pollution control dam in a manner which may detrimentally impact on a water resource - Septic tank (all these tanks are transported via honey sucker to the 7m³ STP located at the mining green area	Septic Tank 7	26°11'06.4"S 28°43'36.5"E	Kenbar 257 IR	10m³
Disposing of waste into the pollution control dam in a manner which may detrimentally impact on a water resource - Septic tank (all these tanks are transported via honey sucker to the 7m³ STP located at the mining green area	Septic Tank 8	26°11'08.4"S 28°43'36.5"E	Kenbar 257 IR	10m³
Disposing of waste into the pollution control dam in a manner which may detrimentally impact on a water resource - Septic tank (all these tanks are transported via honey sucker to the 7m³ STP located at the mining green area	Septic Tank 9	26°11'08.4"S 28°43'37.3"E	Kenbar 257 IR	10m³
Disposing of waste into the pollution control dam in a manner which may detrimentally impact on a water resource - Septic tank (all these tanks are transported via honey sucker to the 7m³ STP located at the mining green area	Septic Tank 10	26°11'10.2"S 28°43'38.1"E	Kenbar 257 IR	10m³
Disused Slimes Dam 1 & 2 that are lined with composite lining	Slimes Dams 1 & 2	26°10'58.6"S 28°43'53.4"E	Kenbar 257 IR	Footprint Area = 2.1Ha Height = 2.5m

Water Uses - Leeuwpan Mine (04/B21A/ABCGIJ/429) Including 18th December 2015 Amendments				
				Length = 40m Breadth = 15m Volume = 88800m^3
Disused Slimes Dam 3 that are lined with composite lining	Slimes Dam 3	26°10'58.6"S 28°43'53.4"E	Kenbar 257 IR	Footprint Area = 1.4Ha Height = 2.5m Length = 40m Breadth = 15m Volume = 111 500m^3
Plant reuse raw water dam compartment 1 - collects contaminated water from the Witklip evaporation Dam, mobile pit water tank, washbay low lying area and Block OD	Raw Water Dam Compartment 1	26°10'52.9"S 28°43'51.6"E	Kenbar 257 IR	Footprint Area = 2.1Ha Height = 2.7m Length = 10m Breadth = 10m Volume = 51 000m^3
Plant reuse raw water dam compartment 2 - collects contaminated water from the Witklip evaporation Dam, mobile pit water tank, washbay low lying area and Block OD	Raw Water Dam Compartment 2	26°10'48.9"S 28°43'51.0"E	Kenbar 257 IR	Footprint Area = 2.2Ha Height = 2.6m Length = 10m Breadth = 10m Volume = 55 000m^3
Wash bay low laying area - the low lying area collects clear water from the oil separator at the workshop & washbay as well as runoff from the washbay for reuse at the washbay or its pumped to the plant raw water dams - unlined	Wash bay low laying area	26°10'55.4"S 28°44'16.0"E	Kenbar 257 IR	Footprint Area = 0.6Ha Height = 0.5m Length = 250m Breadth = 100m Volume = 3007m^3
Mobile pit water tank - this tank collects contaminated water pumped from the open pits and is pumped to the plant raw water dams - steel tank	Mobile pit water tank	26°10'24.9"S 28°44'30.0"E	Kenbar 257 IR	Footprint Area = 0.003Ha Height = 2m Length = 6m Breadth = 6m Volume = 60m^3
Process water storage tank 3 - process water from the plant is stored in this tank - steel tank	Process water storage tank 3	26°10'21.7"S 28°43'51.0"E	Kenbar 257 IR	Footprint Area = 0.035Ha Height = 3m Length = 0m Breadth = 0m Volume = 1050m^3
Process water storage tank 4 - process water from the plant is stored in this tank - steel tank	Process water storage tank 4	26°10'21.7"S 28°43'51.0"E	Kenbar 257 IR	Footprint Area = 0.023Ha Height = 4.7m Length = 0m

Water Uses - Leeuwpan Mine (04/B21A/ABCGIJ/429) Including 18th December 2015 Amendments				
				Breadth = 0m Volume = 1081m^3
Plant raw water tank 1 - contaminated water from the plant raw water dams are stored in this dam for reuse - steel tank	Plant raw water tank 1	26°10'21.7"S 28°43'51.0"E	Kenbar 257 IR	Footprint Area = 0.007Ha Height = 2.5m Length = 0m Breadth = 0m Volume = 166m^3
Workshop Raw Water Tank - this tank stores contaminated water from the plant raw water dams for use at the wash bay - steel tank	Workshop raw water tank	26°10'54.3"S 28°44'18.8"E	Kenbar 257 IR	Footprint Area = 0.003Ha Height = 2m Length = 0m Breadth = 0m Volume = 60m^3
In-pit backfilling - disposal of plant discard from filter press and over burden into the open pits. Front pit area > total area of property on which waste is disposed	In-pit backfilling	26°10'19.7"S 28°42'45.6"E	Kenbar 257 IR	Footprint Area = 1548Ha Volume = 6 432 m^3/d
Low Lying Area 1 - this was an internal catchment area that exists as a result of the location of the infrastructure and the pits at Blocks OH, OM and OD. Only clean runoff was contained in this area. The water surface area at full supply level is 9.5 Hectares. But the area has in the meantime been cleaned up and filled and compacted to be used as product stockpile area. This will be used to contain run-off water from product stockpile beds.	Low Lying Area 1 - Product Stockpile Area	26°10'21.7"S 28°43'51.0"E	Kenbar 257 IR	Footprint Area = 2.1Ha Height = 8m Length = 100m Breadth = 25m Volume = 30 000m^3/a
Conservancy Tank 1 - linked to STP of 4m^3 situated at plant offices	Conservancy Tank 1	26°10'19.6"S 28°43'47.4"E	Leeuwpan 246 IR	10m^3
Conservancy Tank 2 - linked to STP of 4m^3 situated at plant offices	Conservancy Tank 2	26°10'17.3"S 28°43'49.3"E	Leeuwpan 246 IR	10m^3
Conservancy Tank 3 - linked to STP of 4m^3 situated at plant offices	Conservancy Tank 3	26°10'18.8"S 28°43'50.7"E	Leeuwpan 246 IR	10m^3
Conservancy Tank 6 - linked to STP of 4m^3 situated at plant offices	Conservancy Tank 6	26°10'15.7"S 28°43'41.1"E	Leeuwpan 246 IR	10m^3
Conservancy Tank 7 - cleaned by Honey Sucker and disposed	Conservancy Tank 7	26°10'17.5"S 28°43'39.9"E	Leeuwpan 246 IR	10m^3

Water Uses - Leeuwpan Mine (04/B21A/ABCGIJ/429) Including 18th December 2015 Amendments				
into STP of 4m³ situated at plant offices				
Conservancy Tank 8 - cleaned by Honey Sucker and disposed into STP of 4m³ situated at plant offices	Conservancy Tank 8	26°10'24.5"S 28°43'40.7"E	Leeuwpan 246 IR	10m³
Conservancy Tank 16 - cleaned by Honey Sucker and disposed into STP of 4m³ situated at plant offices	Conservancy Tank 16	26°10'22.5"S 28°43'40.6"E	Leeuwpan 246 IR	10m³
Conservancy Tank 19 - cleaned by Honey Sucker and disposed into STP of 4m³ situated at plant offices	Conservancy Tank 19	26°09'57.8"S 28°43'47.8"E	Leeuwpan 246 IR	10m³
Package Sewage Treatment Plant	Package Sewage Treatment Plant	26°10'52.4"S 28°44'22.2"E	Kenbar 257 IR	7m³
Package Sewage Treatment Plant	Package Sewage Treatment Plant	26°92553"S 28°95365"E	Kenbar 257 IR	4m³
Plant Pollution Control Dam - the dam collects runoff from the plant and the coal product stockpiles that is used for dust suppression - Lined Dam, composite lining system	Plant Pollution Control Dam	26°10'02.8"S 28°43'28.5"E	Leeuwpan 246 IR & Wolvenfontein 244 IR	Ha Coverage = 2.1 Ha Height = 1.7m Length = 200m Breadth = 100m Volume = 90 000m³
Load Out Evaporation Dam - Direct rainfall at the load-out station is collected and left out to evaporate - not lined	Load Out Evaporation Dam	26°09'49.2"S 28°43'51.6"E	Leeuwpan 246 IR	Ha Coverage = 0.5Ha Height = 1.5m Length = 25m Breadth = 50m
Process Water Storage tank 1 - Process water tank 1 stores process water used at the plant - steel tank	Process Water Storage Tank 1	26°10'15.6"S 28°43'41.7"E	Leeuwpan 246 IR	Intake Water = 5328 and 20 000 m³ Ha Coverage = 0.038Ha Height = 3m Vol. Used = 1140 m³
Process Water Storage tank 2 - Process water tank 2 stores process water used in the plant - steel tank	Process Water Storage Tank 2	26°10'15.6"S 28°43'41.7"E	Leeuwpan 246 IR	Intake Water = 5328 and 20 000 m³ Ha Coverage = 0.038Ha Height = 3m Vol. Used = 1140 m³

Water Uses - Leeuwpan Mine (04/B21A/ABCGIJ/429) Including 18th December 2015 Amendments				
Plant Raw Water Tank 2 - the tank stores contaminated water from the plant raw water dams for reuse at the plant - steel tank	Plant Raw Water Tank 2	26°10'15.6"S 28°43'41.7"E	Leeuwpan 246 IR	Intake Water = 5328 and 20 000 m^3 Ha Coverage = 0.0063Ha Height = 4.7m Vol. Used = 296 m^3
Jig Thickener Dam - contains water from the Jig Plant dirty water management system - Steel Dam	Jig Thickener Dam	26°10'14.5"S 28°43'41.6"E	Leeuwpan 246 IR	Ha Coverage = 0.00236Ha Height = 4.5m Vol. Used = 740 m^3
Jig Clarified Dam - contains water from the Jog plant water management system - Steel Dam	Jig Clarified Dam	26°10'14.5"S 28°43'41.6"E	Leeuwpan 246 IR	Intake Water = 3 000 m^3 Ha Coverage = 0.00035Ha Height = 4.5m Vol. Used = 160 m^3
Witklip Return Water Dam (Reg. 24059135) - process water from the plant is stored in this return dam. Sized to accept seepage from the under drainage system and decant system for up to 1:50 year rainfall event, over and above normal operating conditions	Witklip Return Water Dam	26°10'23.5"S 28°42'26.3"E	Witklip 229 IR	Intake Water = 5328 (a) and 20 000 m^3 (j) Ha Coverage = 50Ha Height = 4m Length = 100m Breadth = 200m
Witklip Evaporation Dam - the dirty storm water collected in this dam is left to evaporate - Lined with clay - application made with Dam Safety Office	Witklip Evaporation Dam	26°10'23.5"S 28°42'26.3"E	Witklip 229 IR Ptn 4	Intake Water = 5328 (a) and 20 000 m^3 (j) Ha Coverage = 3.3Ha Height = 5.9m Length = 50m Breadth = 50m
Section 21(j)	**Site Name**	**Co-ordinates**	**Property**	**Volume Licenced**
Abstraction of waste water from Block OD	Block OD	26°10'41.6"S 28°43'26.3"E	Kenbar 257 IR	226 992m^3/a
Abstraction of waste water from Block OM	Block OM	S26°10'24.2" E28°44'58.4"	Kenbar 257 IR	20 000m^3/a
Abstraction of waste water from Block OH	Block OH	S26°10'24.2" E28°44'58.4"	Kenbar 257 IR	26 400m^3/a
Abstraction of waste water from Block OJ	Block OJ	S26°09'49.2" E28°45'45.2"	Moabsvelden 248 IR	292 000m^3/a
Abstraction of waste water from Block OWM	Block OWM	S26°09'49.2" E28°45'45.2"	Moabsvelden 248 IR	31 880m^3/a

Table 3.2 Licensed Water Uses (Block OI and OL) (Licence No. 04/B20A/CIJ/4032)

Water Uses - Leeuwpan Mine (04/B20A/CIJ/4032) OI and OL Expansion				
Section 21(a)	**Site Name**	**Co-ordinates**	**Property**	**Volume Licenced**
Pit OI Dewatering	Block OI	S26°10'41.470" E28°45'10.920"	Moabsvelden 248 IR Ptn 2 and 16	72 000m³/annum
Section 21(c) and (i)	**Site Name**	**Co-ordinates**	**Property**	**Watercourse affected**
Open Pit OL	Block OL	S26°10'56.932" E28°45'32.971"	Moabsvelden 248 IR	Bronkhorstspruit
Open Pit OI	Block OI	S26°10'56.932" E28°45'7.258"	Riekkuil 249 IR	Bronkhorstspruit
New plant and infrastructure	New plant and infrastructure	S26°11'3.442" E28°44'22.714"	Kenbar 257 IR	Bronkhorstspruit
Section 21(g)	**Purpose**	**Co-ordinates**	**Property**	**Capacity / Size / Area/ Volume Licenced (m³/a)**
Raw Water Dam	Raw water from collection points will be stored in the raw water dam for use at the plant	S26°10'52.992" E28°43'52.048"	Kenbar 257 IR	28 931m³
Process Water Dam	A process water dam will be required and be located on the Plant terrace next to the storm water collection dam	S26°10'56.282" E28°44'26.069"	Kenbar 257 IR	10 116m³
Storm Water Dam	A storm water dam will be required to the control run-off from the natural environment	S26°10'57.732" E28°44'27.287"	Kenbar 257 IR	9 721m³
Stockpile	Water control measures at the stockpile areas	S26°11'2.249" E28°44'24.339"	Kenbar 257 IR	2 314m³
Dirty Water Dam	A dirty water dam to contain dirty water from the stockyard	S26°11'7.247" E28°44'17.246"	Kenbar 257 IR	11 337.5m³
Discard Backfilling for Pit OI	Pit OI will be backfilled once the mining is completed	S26°10'56.932" E28°45'32.971"	Moabsvelden 248 IR	250 000tons
Discard Backfilling for Pit OL	Pit OL will be backfilled once the mining is completed	S26°10'56.932" E28°45'7.258"	Riekkuil 249 IR	250 000t
Silt Trap	The stormwater dam will spill into the silt trap	S26°10'56.266" E28°44'17.246"	Kenbar 257 IR	9352m³
Dust Suppression	Water for the dust suppression will be	S26°10'02.8" E28°43'28.5"	Leeuwpan 246	7650m³

Water Uses - Leeuwpan Mine (04/B20A/CIJ/4032) OI and OL Expansion				
	collected from the approved PCD's			
Pollution Control Dam	Collection of dirty water.	S26°17'42.6" E29°09'23.7"	Not provided in the WUL.	729 708m³/a
Section 21(j)	**Purpose**	**Co-ordinates**	**Property**	**Volume Licenced**
Pit OI Dewatering	Abstraction of water from the proposed new Block OI to the Raw Water Dam	S26°10'41.470" E28°45'10.920"	Moabsvelden 248 IR Ptn 2 and 16	72 000m³ month total for OI

Table 3.3: Existing Approved Water Uses (Block OI West)

Water Uses - Leeuwpan Mine (06/B20A/CI/9521) OI West				
Section 21(c) and (i)	**Site Name**	**Co-ordinates**	**Property**	**Watercourse affected**
Mining of pan/s and hillslope seep wetland areas at Exxaro Leeuwpan Coal Mine Block OI West	OI West	S26°11'14.44"S E28°44'34.29"E S26°11'13.50"S E28°44'34.56"E	Kenbar 257 IR	Pan/s and hillslope seep wetland

3.2 Existing Lawful Water Uses

Existing Lawful Water Use (ELWU) is defined in Section 32 of the National Water Act 1998, (Act No. 36 of 1998) (NWA) as any water use which has taken place at any time during a period of two years immediately before the date of commencement of the NWA. It also includes any water use which has been declared an existing lawful water use under Section 33 and which was authorised by or under any law which was in force immediately before the date of commencement of the NWA.

As Leeuwpan Coal has been operational since 1992, several of the Water Use activities at the mine commenced before the promulgation of the NWA, 1998. The Existing Lawful Water Uses undertaken at the Existing Leeuwpan Coal in terms of section 21 are listed in Table 3.4.

Table 3.4 Existing Lawful Water Uses under Section 21

Property Name	Section 21	Description	Date Commenced
Witklip 229 IR, Portion 4	(c) & (i)	River diversion. Permit B187/1/220/6 in terms of Section 20 (1)(a) of the Water Act, (Act 54 of 1956).	1993
Witklip 229 IR, Portion 6	(c) & (i)	River diversion. Permit B187/1/220/6 in terms of Section 20 (1)(a) of the Water Act, (Act 54 of 1956).	1993
Witklip 229 IR, Portion 16	(c) & (i)	River diversion. Permit B187/1/220/6 in terms of Section 20 (1)(a) of the Water Act, (Act 54 of 1956).	1993

Property Name	Section 21	Description	Date Commenced
Kenbar 257 IR	(g)	Domestic wastewater disposal	1994
	(g)	In-pit backfilling.	1992
	(g)	Disused Slimes dams No. 1,2 and 3	1994
	(g)	Plant raw water dams.	1992
	(g)	Workshop raw water tank.	1992
Leeuwpan 246 IR	(g)	Domestic Waste Disposal	1994
	(g)	Load out Evaporation Dam	1992
Witklip 229 IR, Portion 4	(g)	Witklip evaporation dam.	1994
Witklip 229 IR, Portion 4	(j)	Pit Dewatering	1992
Kenbar 257 IR	(j)	Pit Dewatering	1992

The ELWUs listed in Table 3.4 were included in the licence that was issued in 2011 (Licence No. 04/B21A/ABCGIJ/429).

WK-BH1 was not licensed as part of the authorisations previously issued and was previously listed as an Existing Lawful Water Use (ELWU) in previous reports.

DHSWS have however, requested that an application be made to license this abstraction. In addition, a second borehole (WK-BH2) is being applied for as a backup supply borehole to supplement Witklip borehole 1 water if water cannot be abstracted from it. Abstraction of water from the two boreholes triggers a water use in terms of Section 21(a) 'taking water from a water resource' of the NWA. The authorisation process requires that an application in the form of a Water Use License Application (WULA) be undertaken.

3.3 Relevant Exemptions

The Minister of the Department of Water and Sanitation is responsible for the protection, use, development, conservation, management and control of the water resources of South Africa on a sustainable basis. The requirements prescribed in terms of the regulations must be seen as minimum requirements to fulfil this goal.

In addition to the water uses that were originally applied for and approved, an application for exemption from certain Government Notice (GN704) activities was also included. These formed part of the IWULs that were issued to Leeuwpan.

3.4 Generally Authorised Water Uses

Leeuwpan's mining operation is a coal mining operation, making it a Category A mine. The water use triggered by the mine is therefore being applied for as a WUL and does not qualify as a General Authorisation.

3.5 New Water Uses to be Licensed

The water abstracted from the Witklip Borehole 1 will be used for coal processing and domestic water supply. The water, once abstracted from the borehole, is pumped to the Silver Tank where it is distributed to the plant as well as the mining area, mining offices and the engineering workshops for domestic use. The borehole water will not be used for drinking purposes. The proposed daily abstraction for Witklip Borehole 1 of 502.74m^3/day amounts to an average annual abstraction of 183 500m^3/year.

The Witklip Borehole 2 has also been included as part of this application process as it will be used as a backup supply borehole should there be any reason that water cannot be abstracted from Witklip Borehole 1 (e.g. pump maintenance). The proposed daily abstraction for Witklip Borehole 2 of 100m^3/day amounts to an average annual abstraction of 36 500 m^3/year. It must be noted that water will not be abstracted from both boreholes at the same time.

The total abstraction triggers the following water use in terms of the NWA:

- Section 21(a) – taking water from a water resource.

The details of the water use to be licensed are presented in Table 3.5 and can be seen in Figure 3.1.

Table 3.5 Section 21(a) Water Use

Water Uses					
Water Use No.	**Section 21(a) Water Use Description**	**Site Name**	**Co-ordinates**	**Property**	**Volume (m^3/a)**
1	Groundwater abstraction for operational use	WK-BH1	26°10'23.88"S 28°42'36.47"E	Witklip 229 IR Portion 4	183 500m^3/a (502.74m^3/day)
2	Groundwater abstraction for operational use (Back-up water for WK-BH1)	WK-BH2	26°10'19.18"S 28°43'10.90"E	Wolvenfontein 224 IR Portion 8	36 500m^3/a (100m^3/day)
Total abstraction from both boreholes					**220 000m^3/a**

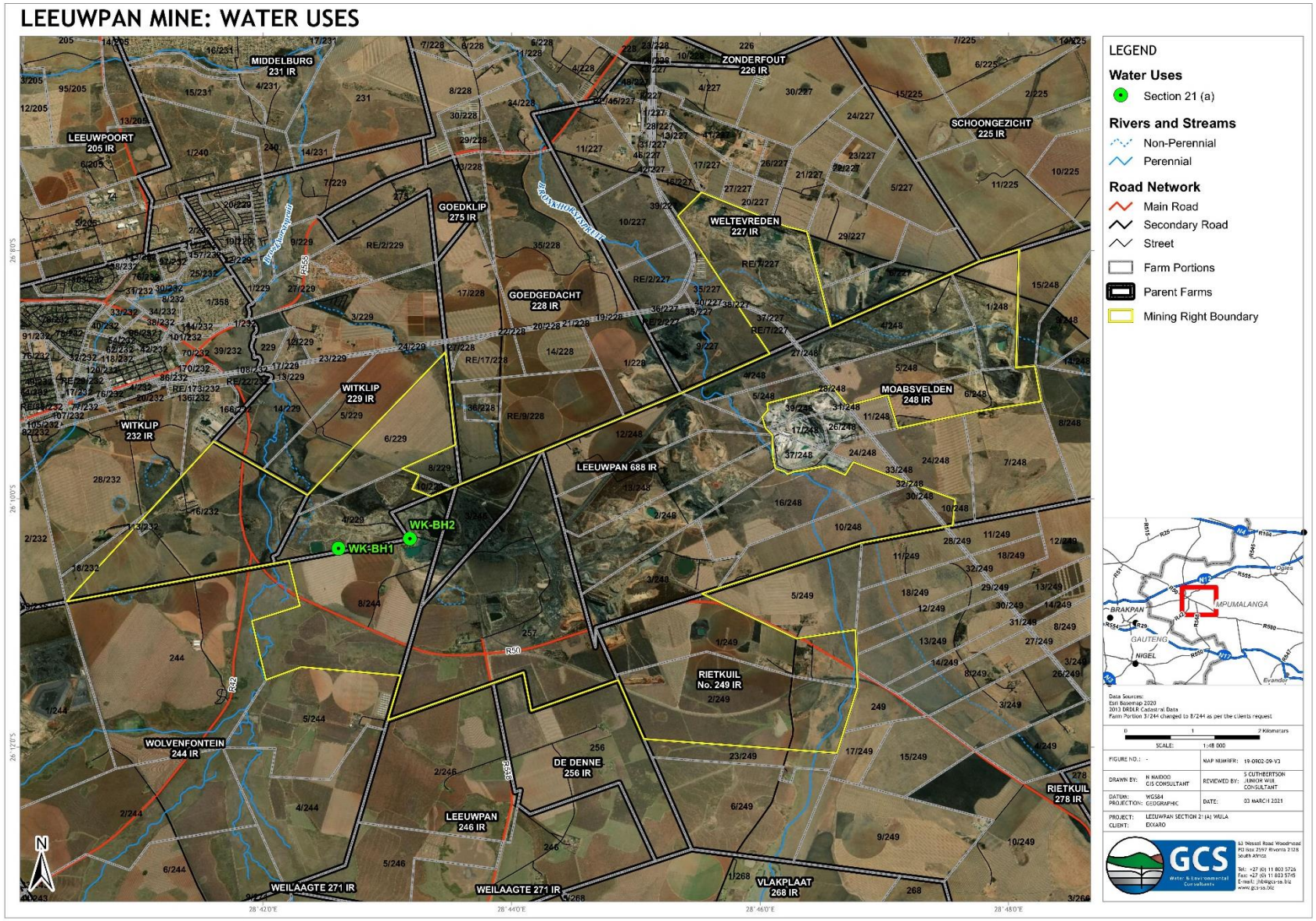


Figure 3.1 Water Use Map

3.6 Waste Management Activities and Waste Related Authorisations

3.6.1 Domestic Waste

The domestic waste that is generated on-site is disposed of into green allocated and marked waste bins/containers. Domestic waste is then collected and disposed of in steel skips located on site (i.e. at the workshop) within the Leeuwpan boundary area. The steel skips are collected by Interwaste and taken to Klinkerstene for disposal. No domestic waste is dumped in any unauthorised landfill site/waste site or dumped in a pit.

Recyclable materials are collected and disposed of into dark blue allocated and marked waste bins / containers.

3.6.2 Mine Waste

Originally, the mine residue consisting of carbon-carrying shales, plant residue and fine coal recovered from the slimes dams, was compacted and disposed of into the mined-out pits below the groundwater table. It was then covered with a clay layer and topsoil so that it would be suitable for agricultural purposes at a later stage.

No mine residue disposal sites were constructed for Block OM, Block OH, Block OFPAD or Block OD. Discard material from these Blocks was placed back into the open pits.

For Blocks OJ and OL (Phase 1) the topsoil was stripped and used in rehabilitation operations. The initial box cut material was also used for the development of the stormwater management berms. Backfilling at Phase 1 Pit took place 45m from the working face. Due to the risk of pollution to the Bronkhorstspruit River, no discard was backfilled into the Phase 1 Pit.

For Block OWM and OD, carbonaceous residue material from the existing Process Plant(s), stockpiled top coal and slurry cakes from the existing filter press, as well as overburden are disposed of back into the pits as part of the mining rehabilitation process.

3.6.3 Hazardous Waste

All hazardous waste (excluding mine waste) is stored in accordance with the minimum requirements for the handling, classification and disposal of hazardous waste – including appropriate roofing, fencing, locking (preventing unauthorised access), labelling, waterproof hard standing, protection from storm water ingress (bunding, etc.), drainage and collection system for spills and general protection from potential environmental pollution.

Any hazardous waste is disposed of in clearly marked black containers, which are then sent to the mine workshop hazardous waste storage area (which is a bunded and roofed area). An additional bunded area for waste storage has been constructed and is in use. This storage area is located within the existing mine boundary area, and waste is removed by a waste contractor (Interwaste) to a licensed waste disposal site.

The hazardous waste storage facility permit that already exists at Leeuwpan has been renewed for the extension (for Blocks OI and OL) of the life of mine.

3.7 Other Authorisations and Regulations

Refer to Table 3.6 for a summary of the existing authorisations obtained for the Leeuwpan mining operation.

Table 3.6 Leeuwpan's Existing Authorisations

Description	Record of Decision (ROD) / Description
Existing Water Use Licences and Amendments	• River diversion. Permit B187/1/220/6 in terms of Section 20 (1)(a) of the Water Act, (Act 54 of 1956). • IWUL for Leeuwpan Mining activities (Licence No. 04/B21A/ABCGIJ/429); • IWUL Amendment (Licence No. 04/B21A/ABCGIJ/429) issued 18th December 2015; • IWUL for R50 road realignment (License No. 06/B20A/CI/5332); • IWUL for TCM Access road (License No. 06/B20A/CI/5333); • IWUL issued for Block OI and OL Expansion (Licence No. 04/B20A/CIJ/4032); and • IWUL issued for Block OI West (06/B20A/CI/9521).
EMPs	• Various EMPs authorised and approved by DMR (5 addendums as referred to above in Section 2.1); • Consolidated EMP, including the proposed expansion activities, approved 25 April 2017 [Reference number: MP 30/5/1/2/3/2/1 (171) EM].
Environmental Authorisation	• Previous NEMA authorisation not required; • Environmental Authorisation received for expansion activities from MDARDLEA (MDEDET reference number: 17/2/3N-180)
Waste Permit	• Leeuwpan has an approved hazardous waste storage facility permit

3.8 Legal Assessment

One of the main and ever-continuing concerns in South Africa is the sustainability of water provision, and the costs associated with the prevention and remediation of pollution in a country with an average rainfall below international standards. The NWA is one of the Government's answers to some of these challenges and is based on the constitutional right to access to sufficient water (Section 27 of the Constitution), and furthermore functions as sectoral legislation within the framework of the National Environmental Management Act, 1998 (Act No. 107 of 1998) (NEMA).

Water management at mines is primarily controlled by the following legislation:

- The NWA;
- The MPRDA and
- The NEMA.

3.8.1 The Constitution of South Africa, 1996 (Act No.108 of 1996)

The Constitution reigns supreme and the advancement of human rights is one of the foundations of South Africa's democracy. Furthermore, the Bill of Rights plays a central role in the democratic regime because it embodies a set of fundamental values which should be promoted at all times. One of the fundamental values is contained in Section 24 and is, arguably, the cornerstone for environmental governance in South Africa which includes the mining industry. Section 24 of the constitution provides:

Everyone has the right:

a) to an environment that is not harmful to their health or well-being;
b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that
    i. prevent pollution and ecological degradation;
    ii. promote conservation; and
    iii. secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

Mining companies are thus duty-bound to constitutional, legislative, and other measures to prevent pollution and ecological degradation, promote conservation and to develop in a sustainable manner.

The constitutional environmental right elevates the importance of environmental protection and conservation and emphasises the significance that South Africans attach to a sound and healthy environment. In addition, the environmental right applies horizontally and this implies that the mining industry has to exercise a duty of care if liability, on the basis of the constitutional environmental right, is to be avoided. The constitutional environmental right is given effect to by means of detailed statutory provisions ranging from framework to sectoral legislation which relate to mining.

3.8.2 The National Environmental Management Act, 1998 (Act No.107 of 1998)

NEMA is South Africa's overarching framework for environmental legislation. The NEMA sets out the principles of Integrated Environmental Management (IEM). NEMA aims to promote sustainable development, with wide-ranging implications for national, provincial, and local government. Included amongst the key principles is that all development must be environmentally, economically and socially sustainable and that environmental management must place people and their needs at the forefront, and equitably serve their physical, developmental, psychological, cultural and social interest.

NEMA is the environmental framework legislation promulgated to replace the Environmental Conservation Act, 1989 (Act No. 73 of 1989), and ensure that the environmental rights contemplated in Section 24 of the Constitution are realised. NEMA sets out:

- the fundamental principles that need to be incorporated in the environmental decision making process;
- the principles that are necessary to achieve sustainable development;
- provides for duty of care to prevent, control and rehabilitate the effect of significant pollution and environmental degradation; and
- it allows for the prosecution of environmental crimes.

The Duty of Care Principle is discussed in Section 28 of NEMA and it states that:

I. Every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from occurring, continuing or recurring, or, in so far as such to harm the environment is authorized by law or cannot reasonably be avoided or stopped, to minimize and rectify such pollution or degradation of the environment;

II. Without limiting the generality of the duty in subsection (1), the persons on whom subsection (1) imposes an obligation to take reasonable measures, include an owner of land or premise, a person in control of land or premises or a person who has a right to use the land or premises on which:

(a) any activity or process is or was performed or undertaken; or

(b) any other situation exists.

Which causes, has caused or is likely to cause significant pollution or degradation of the environment.

The NEMA provides for the identification of activities which will impact the environment. The impacts of the listed activities must be investigated, assessed and reported to the competent authority before authorisation to commence with such listed activities can be granted.

Listed activities under the NEMA didn't come into effect before 2006 and therefore Leeuwpan's existing infrastructure didn't need approval under the NEMA. For the EMPP Addendums 4 and 5 conducted in 2006 – 2007, mining applications were excluded until further notice from the EIA process legislated under the NEMA. Several activities associated with the mining operations that were proposed in Addendums 4 and 5 have however been listed under the NEMA EIA Regulations (No. GNR 385, 386 and 387 of 2006). As was agreed then in consultation with Mpumalanga Department of Land Administration (MDALA), since all activities are directly related to mining, it was not be necessary to obtain authorisation in terms of the EIA Regulations for those addendums.

3.8.3 The Mineral and Petroleum Resources Development Act, 2002 (Act No.48 of 2002)

This Act makes provision for the equitable access to and sustainable development of South Africa's mineral and petroleum resources. Regulations under the Act ensure that activities relating to the mining of minerals are undertaken in a manner that is sustainable and that is equitable to all.

In terms of Section 38 of the MPRDA, mining companies are required to familiarize themselves of potential environmental impacts; manage any environmental impacts; and rehabilitate the environment in so far as is reasonably possible. Furthermore, Section 38(1)(e) states that such holders, whose mining causes or results in ecological degradation, pollution, or environmental damage that may be harmful to the health or well-being of anyone:

"…is responsible for any environmental damage, pollution or ecological degradation as a result of his or her operations and which may occur inside and outside the boundaries of the area to which such right, permit or permission relates."

These holders will ***"…remain responsible for any environmental liability, pollution or ecological degradation and the management thereof until a closure certificate has been issued"***.

Section 39 provides that a mine must indicate how it will contain or remedy the cause of pollution or degradation and migration of pollutants and comply with any prescribed waste standards or management practice.

Granting of permission to mine or prospect, among others, is conditional on an environmental management programme and plan being submitted and accepted by the relevant government authority. Section 43 is one of the most important provisions as it deals with the responsibility for any environmental liability, pollution or ecological degradation until the issue of the closure certificate. It is important to note that environmental liability will not necessarily cease or fall away by the issuing of a closure certificate. In addition to the broader liability provisions above, Section 45 provides that the relevant authority may direct a mine to undertake remedial measures where:

"...any prospecting, mining, reconnaissance or production operations cause or results in ecological degradation, pollution or environmental damage which may be harmful to the health or well-being of anyone and requires urgent remedial measures."

Where the mine fails to take these measures, the relevant authority will act on its behalf and then recover costs incurred from the mine. If the mine fails to compensate the authority, the latter is empowered to seize and sell the mine's property to recover the costs. The mine will thus remain financially liable for the rehabilitation, even if it chooses to ignore the government directive.

3.8.4 The National Water Act, 1998 (Act No.36 of 1998)

Section 19 of the NWA mirrors the provision of Section 28 of NEMA and addresses the prevention and remediation of the effects of pollution. The NWA provides a wide duty of care in that:

"(1) an owner of land, a person in control of land or a person who occupies or uses the land on which-

(a) any activity or process is or was performed or undertaken; or

(b) any other situation exists, which causes, has caused or is likely to cause pollution of a water resource must take all reasonable measures to prevent any such pollution from occurring, continuing or recurring."

The words "likely to cause pollution" broadens the scope of the duty, which enables an activity, or situation that is land-based, to trigger the application of the duty. The "reasonable measures" are not prescribed, but may include measures intended to:

"cease, modify or control any act or process causing the pollution; comply with any prescribed waste standard or management practice; contain or prevent the movement

of pollutants; eliminate any source of pollution; remedy the effects of pollution; and remedy the effects of any disturbance to the bed and banks of a watercourse."

The NWA, furthermore, provides for water use authorisations which a mine will have to apply for, before commencing with its primary activity of mining. Various conditions may be attached to these licenses and a breach thereof will result in criminal and civil liability. The conditions attached to water use authorisations will function alongside the additional protective measures, duty of care and statutory liability provisions provided by the NWA and other legislation to regulate a whole array of water issues.

The detrimental impact of mining on water resources is further regulated by the NWA in a comprehensive set of regulations titled: *"Regulations on the Use of Water for Mining and Related Activities Aimed at the Protection of Water Resources"* (GN R704 of 4 June 1999) (hereinafter referred to as the "*NWA: Mining Water Regulations*"). In terms of these regulations:

"No person in control of a mine or [mining] activity may place or dispose of any residue or substance which causes or is likely to cause pollution of a water resource, in the workings of any underground or opencast mine excavation, prospecting diggings, pit or any other excavation."

Regulation 7 provides for a whole array of provisions which specifically aim to protect water resources from mining. These provisions state that every person in control of a mine or mining activity must take all reasonable measures to, inter alia: prevent water containing waste or any substance which causes or is likely to cause pollution from entering any water resource; design, modify, locate, construct and maintain all water systems including residue deposits, to prevent the pollution of any water resource through the operation or use thereof; cause effective measures to be taken to minimise the flow of any surface water or floodwater into mine workings, opencast workings, other workings or subterranean caverns; prevent the erosion or leaching of materials from any residue deposit or stockpile from any area; and ensure that water used in any process at a mine or activity is recycled as far as practicable. These provisions specifically relate to the protection of water resources and they clearly set out further additional liabilities for mines as far as their water resource protection activities are concerned.

Activities which have the potential to impact on a water resource require a water use licence (WUL) issued by the DHSWS, under the NWA. Section 21 of the NWA identifies certain water uses which have to be authorised.

Furthermore, Section 27 of the NWA specifies that the following factors, regarding water use authorization, must be taken into consideration:

- The efficient and beneficial use of water in the public interest;
- The socio-economic impact of the decision whether or not to issue a license;
- Alignment with the catchment management strategy;
- The impact of the water use and possible resource directed measures; and
- Investments made by the applicant in respect of the water use in question.

Section 27 considerations is included in the as an annexure (Annexure A) to this report. This will assist the mine in ensuring that the water uses applied for, are undertaken in a manner that does not negatively impact on the public, water resources, or downstream water users or compromise any of the country's international obligations with regards to shared water resources.

4 PRESENT ENVIRONMENTAL SITUATION

4.1 Climate

4.1.1 Regional Climate

The mine site is located in a temperate climatic zone of South Africa, which is characterised by warm summers and dry cold winters. Table 4.1 shows that the area experiences – on average - lowest temperatures in July and is warmest during January. The monthly average minimum and maximum temperatures recorded in the town of Delmas are 7.7°C and 23.6°C, respectively.

Table 4.1 Average minimum and maximum temperatures at Delmas

Temperature	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum (°C)	14.0	13.4	11.7	8.0	3.0	-0.6	-1.6	1.2	6.2	10.1	12.4	14.0
Maximum (°C)	27.0	26.3	25.6	23.8	21.8	18.1	18.9	20.7	24.1	25.1	25.2	26.4

4.1.2 Rainfall

The Mean Annual Precipitation (MAP) for the Leeuwpan site is 661.2mm/a (GRDM, 2013). The rainfall characteristics typify wet summers and dry winters.

4.1.3 Evaporation

According to WR2012, a mean annual evaporation of 1 677mm is typical of the Leeuwpan area and its distribution can be seen in Figure 4.1. The summer months have higher rates of evaporation than the winter months.

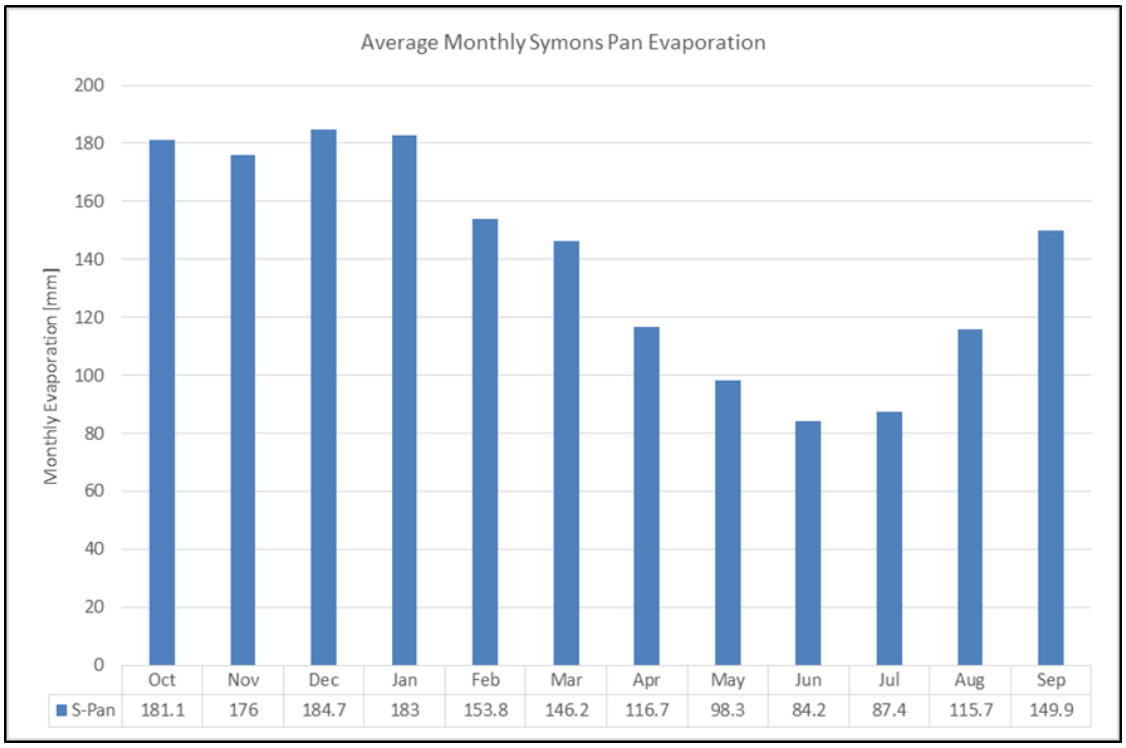


Figure 4.1 S-Pan Evaporation at Leeuwpan

4.2 Surface Water

4.2.1 Water Management Area

The project area is located in the Olifants Water Management Area and falls within the B20A quaternary catchment (Figure 4.2).

With reference to 'The PES EIS 2014 models,' DHSWS has identified that the Drainage Region B2 is classified as:

- Moderate in its Ecological Importance and Sensitivity (EIS); and
- Largely Modified, Class D in its Present Ecological State (PES).

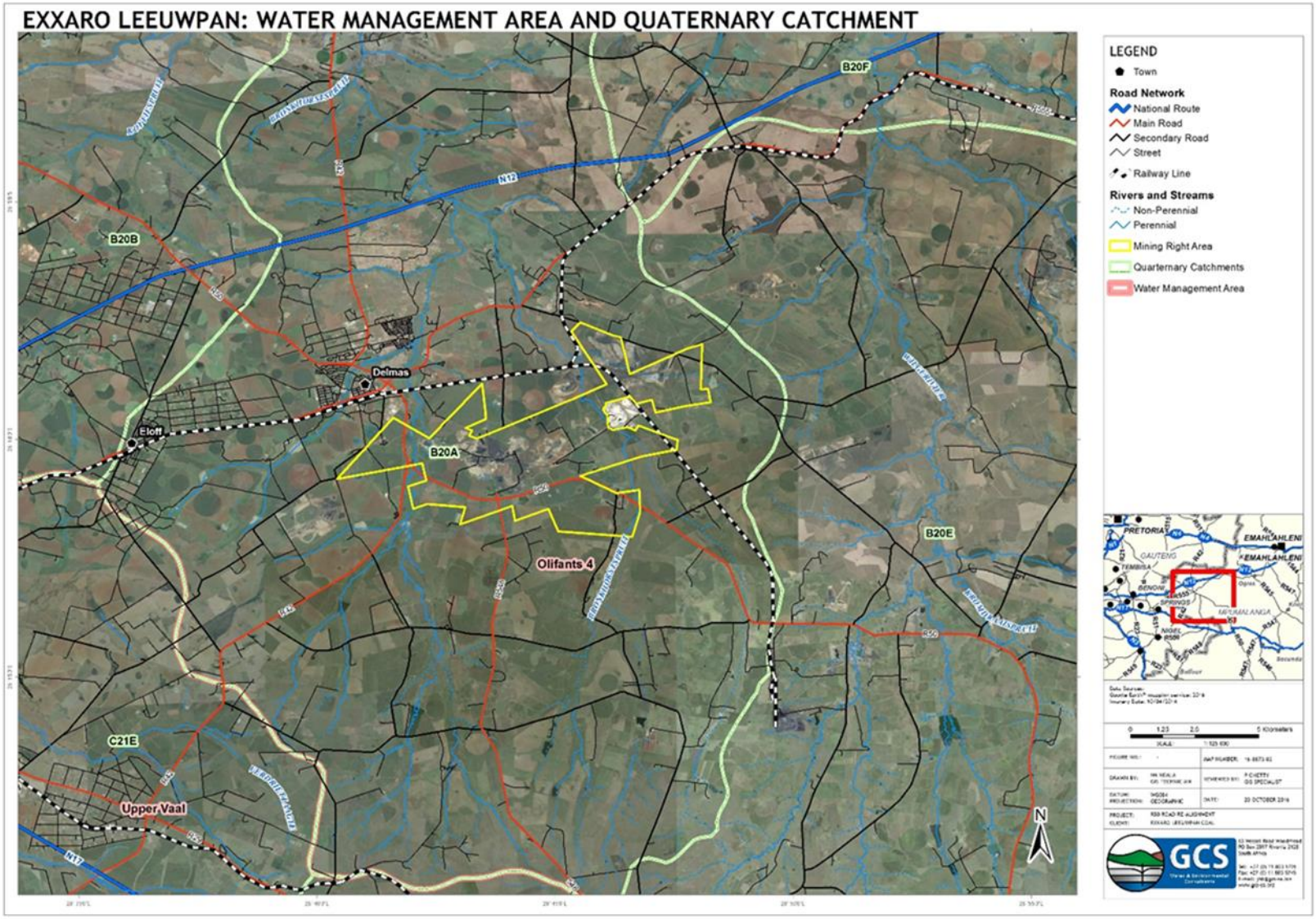


Figure 4.2 Water Management Area of Leeuwpan

4.2.2 Surface Water Hydrology

The Bronkhorstspruit River flows in a south-north direction through the site to eventually end in the Bronkhorstspruit Dam downstream of the site area. Natural water features on site include tributaries of the Bronkhorstspruit River and pans. Artificial water features on site include farm dams, old void areas, Pollution Control Dams (PCD's), rain water in open cast pits and river diversion channels.

4.2.3 Surface Water Quality

The surface water quality results were obtained from the Monthly Water Quality Report conducted by Environmental Assurance (Envass) in October 2020 (Annexure C). Refer to Section 5.4.1 for the details pertaining to the surface water monitoring points.

4.2.3.1 Receiving Environmental Water Quality

Surface water monitoring was performed at ten (10) monitoring localities during the monitoring period. The following samples were recorded as dry during the site assessment: LSW06, LSW07, LSW08, LSW12, WP01 and RD1.

The majority of the sampled receiving environment monitoring localities water quality analysis indicated exceedances in terms of the DWAF Domestic Guideline Limits for Turbidity, Calcium and Dissolved Organic Carbon (DOCmg/l). Additional exceedances included the Calcium (Ca), Magnesium (Mg), Sulphate (SO_4), Manganese (Mn) and *E.coli*.

From the October 2020 results it is evident that the majority of the receiving environment monitoring localities presented overall fair condition. Turbidity within the surface water samples are expected, as turbidity refers to the measurement of the cloudiness or muddiness of water, which is influenced by both natural (flow velocity, rainfall, run-off etc.) and anthropogenic activities (disturbance/mining activities). Overall, the Total Inorganic Nitrogen (TIN), Nitrate (NO_3-N) and the Ammonia (NH_3-N) levels remained low, with the majority (excluding LSW13) of the concentrations recording below the detection limit.

Duplicate samples were obtained from monitoring localities LSW03, LSW05 and WP02 in order to determine the accuracy and precision of inter-laboratory results. Comparison of the calculated TDS and computation of relative percent difference for the duplicate pairs were calculated between a range of 0.0 to 3.65% for the October 2020 monitoring run, recording within the acceptable range (30%).

4.2.3.2 Process Water Quality

Process water monitoring was performed at sixteen (16) monitoring localities during the monitoring period. The following samples could not be obtained during the monitoring run: KR03, KR04, OG PIT, OH PIT, OJ PIT, OM PIT, WLV PIT and OWM-PIT. Refer to the sampling register as presented in Appendix A of Annexure C for details.

All of the monitored process localities revealed compliance to the stipulated WUL limits. The October 2020 exceedances can be summarised as follows:

- **KR01A , LSW09 and WP04:**
    - General Authorisation Limit: Electrical Conductivity (EC) and Manganese (Mn).
- **ODN PIT:**
    - General Authorisation Limit: Electrical Conductivity (EC) and Manganese (Mn) WUL Limit: *E.coli*.

Discharge of the process water into the receiving environment is prohibited according to the General Authorisation (Section 21f and h, 2013) as it could have limiting effects on the receiving water environment. Note that regular maintenance on process water facilities linings and transfer pipes are vital for water resource protection.

4.2.3.3 Effluent Water Quality

Final effluent samples are collected at two (2) monitoring localities inclusive of the Septic tanks at plant and the Final effluent from the sewage plant.

The final effluent from LWP-SP-P historically recorded non-compliant to the set Ammonia Wastewater WUL limits, while exceedances related to the General Authorisation limits included Suspended Solids, Ammonia and Chemical Oxygen Demand.

During the monitoring period it was noted that the LWP-SP-P was not active and no access was obtained to the LWP-SP-W monitoring point.

4.2.3.4 Potable Water Quality

Four (4) potable water localities form part of the monitoring programme at Exxaro Leeuwpan Mine. **It should be noted that the water is not used as a potable source, however monitored as such in case of accidental consumption as a precautionary measurement**. During the monitoring period a sample could not be obtained from PIET-SCHUTTE as water was not pumping.

The potable water quality at Leeuwpan can generally (historical results) be described as neutral, non-saline and hard while elevated salinity and Total Hardness was present from Load-Out Bay Offices (LLBDW) and Drinking Water at Laboratory (LWDL) during October 2020. The Load-Out Bay Offices (LLBDW) revealed exceedances of Electrical Conductivity (EC), Total Dissolved Solids (TDS), Sulphate (SO_4), Turbidity, Heterotrophic Plate Counts and E.coli which renders the water as not suitable for potable purposes. The Drinking Water Supply Tank (LDWST) presented an exceedance of Heterotrophic Plate Counts, while the remainder of the parameters presented ideal water quality. The Drinking Water at Laboratory (LWDL) presented an exceedance of Electrical Conductivity (EC), Total Dissolved Solids (TDS), Sulphate (SO4) and Heterotrophic Plate Counts.

Based on the historical analysed parameters and data, the potable water poses a risk for infection due to the elevated Heterotrophic Plate Counts and thus it is strongly advised that the water be treated and filters regularly disinfected and cleaned as the high counts may be attributed to biofilms.

4.2.3.5 Conclusion and Aspects to Consider

The scope of work performed at the Leeuwpan Coal Mine is as per WUL requirements as listed in this report. This report aims to highlight the conditions requirements of the WUL as well as aspects that are to be considered in order to improve compliance of the IWUL.

During the monitoring period samples LSW06, LSW07, LSW08, LSW12, WP01, RD1, KR03, KR04, OG PIT, OH PIT, OJ PIT, OM PIT, WLV PIT, LWP-SP-W, OWM-PIT and PIET-SCHUTTE could not be obtained during the monitoring period due to access issues.

Based on the historical analysed parameters and data, the potable water poses a risk for infection due to the elevated Heterotrophic Plate Counts as well as health risks. It is strongly advised that the water not be used for potable or domestic purposes and “no-drinking signs” be present as current implemented.

Exceedances of Ca, Mg, Turbidity, Dissolved Organic Carbon (DOC) and indicated presence of Oil and Grease were presented at the receiving environment. From the results it is evident that the majority of the receiving environment monitoring localities presented overall fair condition with general low salinity content.

The process water samples revealed compliance to the stipulated WUL limits, except for the ODN-PIT monitoring point which exceeded the limit for E.coli. Discharge of the process water into the receiving environment is prohibited according to the General Authorisation (Section

21f and h, 2013) as it could have limiting effects on the receiving water environment. Note that regular maintenance on process water facilities linings and transfer pipes are vital for water resource protection.

Representative samples related to October 2020 could not be obtained thus the final effluent from LWP-SP-P historically recorded non-compliant to the set Ammonia Wastewater WUL limits, while exceedances related to the General Authorisation limits included Suspended Solids, Ammonia and Chemical Oxygen Demand.

During the monthly monitoring period, the majority of the localities presented relatively stable conditions compared to September 2020, with fluctuation in bacteriological content noted.

Aspects to consider:

- The potable water poses a risk for infection based on the elevated bacteriological and thus it is strongly advised that the water be treated and filters regularly disinfected and cleaned as the high counts may be attributed to biofilms, however warning signs have been implemented indicating water is unfit for human consumption;
- Clean and dirty stormwater must be separated as reasonably possible;
- All waste water be contained and not released into the receiving environment;
- All spills and incidents be reported to the Sustainability Manager; and
- Immediate reporting of any polluting or potentially polluting incidents be implemented.

4.2.4 Mean Annual Runoff

The climate data used in this study were obtained from the Water Resources of South Africa, 2012 Study (WRC, 2012) which contains the climatic and catchment information of each quaternary catchment in South Africa. The project site is located in Quaternary Catchment B20A of the Olifants WMA. The Mean Annual Precipitation (MAP) calculated for this area is 668mm while the Mean Annual Evaporation (MAE) is 1 677mm and the Mean Annual Runoff (MAR) is 25.6 minimum control measure (mcm). Table 4.2 provides the average climatic data.

Table 4.2 B20A - Mean Monthly & Annual Precipitation, Evaporation and Runoff

Month	Precipitation (mm)	Evaporation (mm)	Runoff (mcm)
Oct	66	181	1.3
Nov	105	176	2.1
Dec	109	185	2.5
Jan	118	183	3.9
Feb	90	154	4.2

Month	Precipitation (mm)	Evaporation (mm)	Runoff (mcm)
Mar	84	146	3.5
Apr	40	117	2.2
May	17	98	1.7
Jun	8	84	1.3
Jul	5	87	1.1
Aug	6	116	1.0
Sep	19	150	0.8
Annual	**668**	**1677**	**25.6**

4.2.5 Resource Class and River Health

In South Africa, a river health classification scheme is used to standardise the output of different river systems. The document titled "Resource Directed Measures for Protection of Water Resources: River Ecosystems Version 1.0.24", dated September 1999, compiled by the DWS (now DHSWS), provides the indexes of Attainable Ecological Management Classes (AEMC) as shown in Table 4.3. Each index is calibrated so that its results can be expressed in terms of ecological and management perspectives.

Table 4.3 Resource Classes at set out by the DWS

River Health Class	Ecological perspective	Management perspective
Natural / Excellent (Class A)	No or negligible modification of in-stream and riparian habitats and biota	Protected rivers; relatively untouched by human hands; no discharge or impoundments allowed
Good (Class B)	Ecosystems essentially in good state; biodiversity largely intact	Some human-related disturbance but mostly of low impact potential
Fair (Class C)	A few sensitive species may be lost; lower abundance of biological populations are likely to occur, or sometimes, higher abundances of tolerant or opportunistic species occur.	Multiple disturbances associated with need for socio-economic development, e.g. impoundment habitat modification and water quality degradation
Poor Class D)	Habitat diversity and availability have declined; mostly only tolerant species present; species present are often diseased; population dynamics have been disrupted (e.g. biota can no longer reproduce or alien species have invaded the ecosystem)	Often characterised by high human densities or extensive resource exploitation. Management intervention is needed to improve river health – e.g. to restore flow patterns, river habitats or water quality.

According to the "Classes and Resource Quality Objectives of Water Resources for The Olifants Catchment" published on the 22nd of April 2016 in the Government Gazette No.39943, Regulation 466, the Bronkhorstspruit river catchment falls into the Ecological Management Class C as defined in Table 4.4.

Table 4.4 Resource Classes for the Bronkhorstspruit

River Name	Integrated Unit of Analysis (IUA)	Water Resource Class for IUA	Biophysical Node Name	Quaternary Catchment	Ecological Category to be maintained
Bronkhorstspruit (outlet of quaternary)	2 Wilge River catchment area	II	HN21/RU21	B20A	C

4.2.5.1 Receiving Water Quality Objectives

Constant increases in water demands, particularly from the Olifants River, motivated the DHSWS to investigate the water requirements of users in terms of both water quantity and quality, as well as the current management of the water resource. According to the "Classes and Resource Quality Objectives of Water Resources for The Olifants Catchment" published on the 22nd of April 2016 in the Government Gazette No.39943, Regulation 466, no Resource Water Quality Objectives (RWQOs) have been set for the Bronkhorstspruit.

RWQOs have however been set for the Wilge River, of which the Bronkhorstspruit merges downstream. The RWQOs for the Wilge River at the outlet of the identified IUA (in quaternary catchment B20J) are presented in Table 4.5.

Table 4.5 Wilge River RWQOs

Sulphates	<200mg/L
F	≤ 2.50 mg/L
Al	≤ 0.105mg/L
Pb hard	≤ 9.5 µg/L
As	≤ 0.095mg/L
Se	≤ 0.022mg/L
Cd hard	≤ 3.0 µg/L
Cr(VI)	≤ 121 µg/L
Cu hard	≤ 6.0 µg/L
Hg	≤ 0.97 µg/L
Mn	≤ 0.990mg/L
Zn	≤ 25.2 µg/L
Chlorine	≤3 dissolve.1 µg/L free Cl
Endosulfan	≤ 0.13 µg/L
Atrazine	≤ 78.5 µg/

4.2.6 Surface Water User Survey

There are four (4) main uses of water that have been identified for the sub catchment of the Bronkhorstspruit up to the receiving water body, namely the Bronkhorstspruit Dam. The surface water uses include the following:

- Domestic use by formal and informal communities along the affected watercourse;
- Irrigation of crops, especially maize;
- Livestock watering including cattle, sheep and poultry; and

- Aquatic ecosystems including fish, macro and micro-invertebrates.

Very few water bodies in the Delmas area are used for recreational purposes due to their seasonal nature. In most cases, dams are used for fishing.

No direct abstraction of water from the Bronkhorstspruit occurs for commercial irrigation or extensive domestic use. Dams are usually filled with water from the boreholes and this clean water is mainly used for irrigation. Numerous pans occur in the Delmas area but are not utilised as a source of water for the above mentioned purposes.

4.2.7 Sensitive Areas (Wetlands)

A Wetland Delineation Assessment was conducted by Wetland Consulting Services (Pty) Ltd in 2012 and can be found in Annexure G. The National Wetland Inventory (SANBI, 2011) and the Atlas of Freshwater Ecosystem Priority Areas in South Africa (Nel et al., 2011) indicates a number of valley bottom, hillslope seepage and pan wetlands as occurring on site. None of the wetlands are classed as FEPA's (Freshwater Ecosystem Priority Areas), and no FEPA wetlands occur within 3km of the study area boundary.

4.2.7.1 Wetland Delineation

In total, the area classified as wetland covers 1 382ha of the total mining right area, which makes up roughly 32.5% of the study area. Approximately 820ha of the site has however already been disturbed by surface mining activities, suggesting that the wetland extent on site was likely significantly more prior to the onset of mining activities. Table 4.6 summarises the wetlands located within the mining right area.

Table 4.6 Extent of wetland types identified on site

Wetland Type	Wetland Area (ha)	% of wetland area	% of study area
Channelled Valley Bottom	77.77	5.63	1.83
Hillslope Seepage	906.55	65.58	21.28
Pan	37.02	2.68	0.87
Unchannelled Valley Bottom	321.78	23.28	7.55
Dam	35.98	2.6	0.84
River Diversion	3.15	0.23	0.07
Total	1382.25	100	32.45

The wetland extent on site is dominated by extensive hillslope seepage wetlands. These wetlands make up more than 65% of the wetland area on site and cover more than 20% of the entire site. The majority of the seepage wetlands are considered seasonal to temporary wetlands (i.e. implying temporary to seasonal saturation of the soil profile) that are maintained by a shallow perched water table within the soil profile. The perched water table is derived and maintained from rainfall that infiltrates the soil profile and is prevented from

deeper infiltration by an aquitard within the soil profile, usually a hard of soft plinthic layer. It is suspected that little interaction between deeper groundwater and this perched water table occurs, though no testing or modelling to support this statement was undertaken on site.

In many areas, the temporary edges of the hillslope seepage wetlands have been cultivated and are either still currently under maize cultivation or have been converted to planted pastures. Especially on the Farm Rietkuil, the intrusion of cultivation into the hillslope seepage wetlands has been extensive. Nonetheless, the remaining areas of hillslope seepage wetland characterised by natural vegetation represent, together with the two large valley bottom wetlands, the largest expanse of natural grassland within the study area.

Three (3) valley bottom wetlands were delineated within the study area (refer to Figure 4.3), consisting of the Bronkhorstspruit and two of its tributaries. Some confusion exists with regards to the naming of the Bronkhorstspruit, as the 1:50 000 topographical maps name the large valley bottom wetland in the east of the site as the Bronkhorstspruit, while road signs along the R50 tar road name the western valley bottom as the Bronkhorstspruit. For the purpose of this study, the naming as per the 1:50 000 topographical maps will be followed.

The Bronkhorstspruit valley bottom wetland consists of a broad, mostly unchannelled system characterised by vertic clay soils. The upper catchment as well as the upper reach of the wetland on site is utilised agriculturally, with livestock grazing the main activity within the wetland. On site, mining takes place on either side of the wetland and includes the Silica Mine that extends significantly into the wetland. A dam as well as several berms have been constructed within this reach of the wetland to control flows through the mining area. Downstream of the study area the character of the wetland changes significantly as flows become confined and a clearly incised channel forms where the alluvial deposits associated with the upper wetland end and the river flows over dolomite.

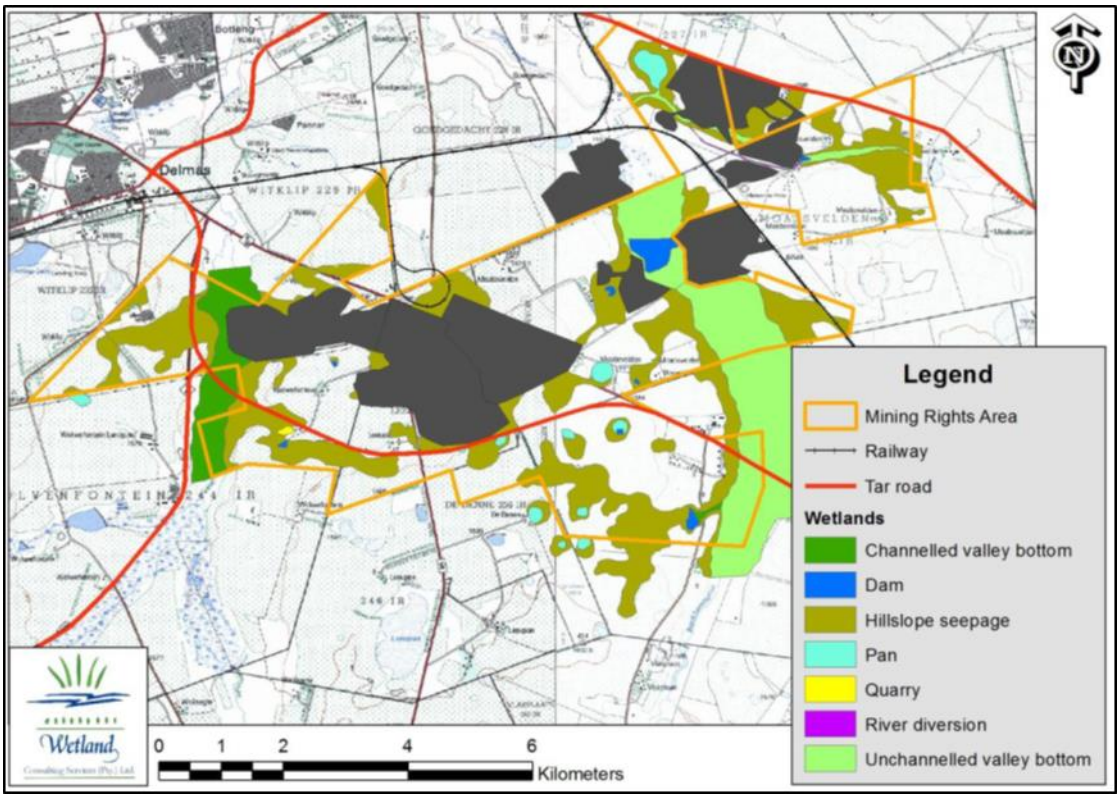


Figure 4.3 Identified Wetland Areas

A small unnamed tributary enters the Bronkhorstspruit from the east. This valley bottom wetland passes between the Leeuwpan mining activities and the Stuart East Colliery mining area and has necessitated a river diversion. A dam has been constructed on the upstream side of the mining activities and channels flows via a narrow, approximately 3m wide trench, around the mining activities.

In the east of the study area a further unnamed tributary of the Bronkhorstspruit flows from south to north across the study area. This is again a broad valley bottom wetland characterised by mostly vertic soils, though in contrast to the Bronkhorstspruit system on site, this system is clearly incised. Existing mining activities also extend into this wetland system and have required the construction of a large berm to divert flows around the mine activities. This activity has been authorized under the WULA that was submitted and approved for the mining of the OWM Reserves (Koos Smit, pers. comm., 2013)

Eight (8) pans occur within the study area, ranging in size from 0.4 to over 18ha. Most of these pans are shallow, seasonal depressions that are characterised by *Leersia hexandra* across their full width, though the pan at sampling point LP2 (see Figure 4.4 below) appears to be a permanent pan as it is lined by *Phragmites australis*. This pan is thought to be used as water storage for irrigation and is thus a highly modified system. A number of further pans

have been significantly impacted by the construction of roads and irrigation dams within the pan basins.

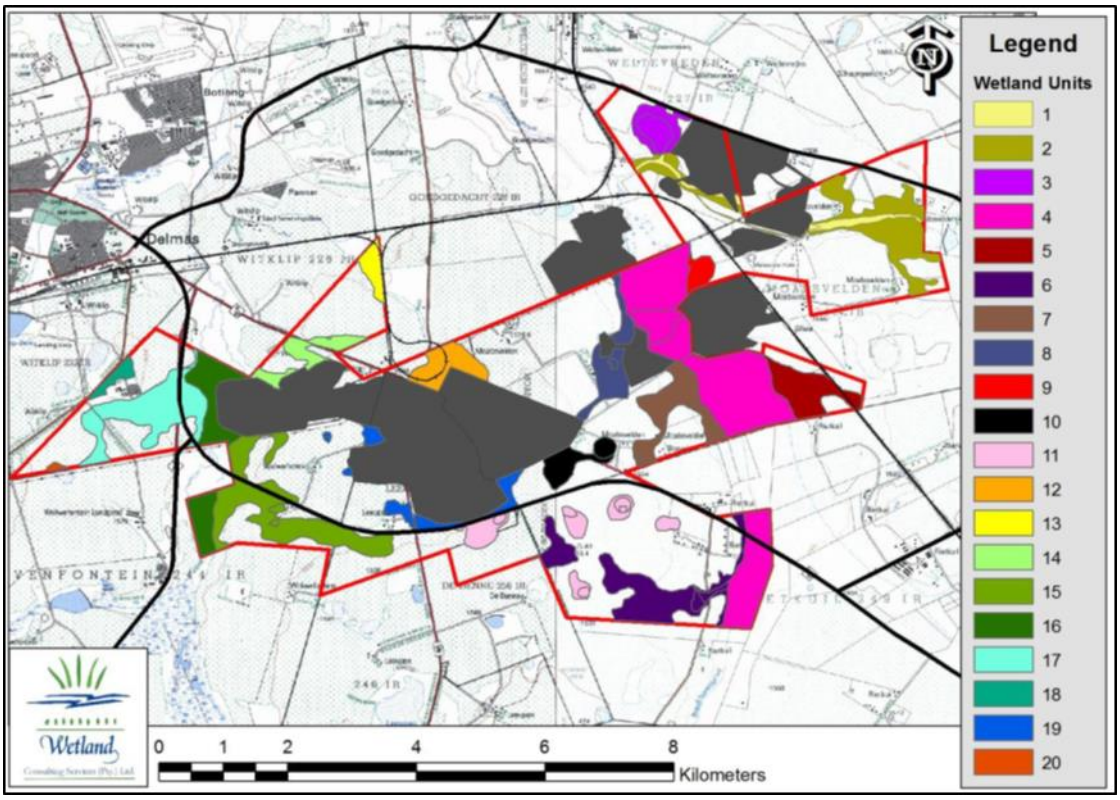


Figure 4.4 Map showing wetland units

4.2.7.2 Functional Assessment

Wetlands have been shown to perform a wide range of functions related to water quality improvement, flood attenuation, resource provision and erosion control, among others. However, each wetland is unique in the extent to which it is able to perform these functions, and the opportunity it is provided to perform these functions.

Many of the functions and services attributed to a wetland are inferred from the HGM classification of the wetland, as well as the levels of disturbance, cultural importance, and potential for the wetland to perform various functions. The nature of the functions that the wetlands perform and the services they provide were assessed using the WET-Eco Services tool, whereby both existing information and a field assessment were required.

At a site specific scale, as well as at the local and regional scale, the wetlands (especially the large valley bottom wetlands) represent the dominant remaining extent of natural vegetation and thus play a highly significant role in biodiversity support at this level. Virtually all terrestrial habitat on site has been significantly transformed due to agricultural and mining

activities and most terrestrial areas are under cultivation, forcing species that under natural conditions might not be directly dependent on wetland habitats to frequent wetland habitats on site.

Loss of the wetland habitat on site would thus result not only in the loss of wetland dependent fauna, but also impact significantly on terrestrial faunal species that remain on site. At the National and International level, the importance of many of the smaller hillslope seepage wetlands and pans in biodiversity support is limited due to the disturbances that have already taken place within these systems, the generally low species richness of wetlands compared to other ecosystems (e.g. terrestrial grassland), and the limited number of Red Data species likely to occur on site.

Hillslope Seepage Wetlands:
As alluded to earlier, hillslope seepage wetlands are maintained by shallow sub-surface interflow, derived from rainwater.

Rainfall infiltrates the soil profile, percolates through the soil until it reaches an impermeable layer (e.g. a plinthic horizon or the underlying sandstone), and then percolates laterally through the soil profile along the aquitard (resulting in the formation of a perched water table). Such a perched water table occurs across large areas of the Mpumalanga Highveld, not only within hillslope seepage wetlands, but also within terrestrial areas, only at greater depth.

The hillslope seepage wetlands are merely the surface expression of this perched water table in those areas where a shallow soil profile results in the perched water table leading to saturation of the profile within 50cm of the soil surface. The importance of individual seepage wetlands in temporarily storing and then discharging flows to downslope wetlands (flow regulation) varies and depends on a number of factors. Generally, seepage wetlands associated with springs and located adjacent to terrestrial areas characterised by deep, well-drained soils are more likely to play an important role in flow regulation than seepage wetlands where the wetland and catchment are characterised by shallower soils. Such seepage wetlands are likely often maintained mostly by direct rainfall and lose most of their water to evapotranspiration, and surface run-off during large storm events.

Hillslope seeps can support conditions that facilitate both sulphate and nitrate reduction as interflow emerges through the organically rich wetland soil profile and are thus thought to contribute to water quality improvement and/or the provision of high quality water. The greatest importance of the hillslope seepage wetlands on site is thus taken to be the

movement of clean water through the hillslope seepage wetlands and into the adjacent valley bottom wetlands, though the flow contribution from hillslope seepage wetlands to downslope wetlands was not quantified.

As hillslope seepage wetlands, for the most part, are dependent on the presence of an aquiclude, either a hard or soft plinthic horizon, they are not generally regarded as significant sites for groundwater recharge (Parsons, 2004). However, by retaining water in the landscape and then slowly releasing this water into adjacent valley bottom or floodplain wetlands, some hillslope seepage wetlands can contribute to stream flow augmentation, especially during the rainy season and early dry season.

From an overall water yield perspective there is evidence that seepage wetlands contribute to water loss. The longer the water is retained on or near the surface the more likely it is to be lost through evapo-transpiration (McCartney, 2000).

Hillslope seepage wetlands are not generally considered to play an important role in flood attenuation, though early in the season, when still dry, the seeps have some capacity to retain water and thus reduce surface run-off. Later in the rainy season when the wetland soils are typically saturated, infiltration will decrease and surface run-off increase. Further flood attenuation can be provided by the surface roughness of the wetland vegetation; the greater the surface roughness of a wetland, the greater is the frictional resistance offered to the flow of water and the more effective the wetland will be in attenuating floods (Reppert et al., 1979).

In terms of the hillslope seepage wetlands on site, the surface roughness is taken to be moderately low, given that most of the seepage wetlands are either cultivated of characterised by typical grassland vegetation, thus offering only slight resistance to flow.

Valley Bottom Wetlands:

The linear nature of valley bottom wetlands within the landscape and their connectivity to the larger drainage system provides the opportunity for these wetlands to play an important role as an ecological corridor allowing the movement and migration of fauna and flora between remaining natural areas within the landscape.

Although modified in certain respects due to changes in land use having brought about hydrological changes to these wetlands as well as vegetation transformation, the wetlands still provide a natural refuge for biodiversity, and within the study area and surroundings, the large valley bottom wetlands with associated footslope seepage wetlands represent the

most significant extent of remaining natural vegetation, further enhancing their importance from a biodiversity support function.

Channelled valley bottom wetlands, through the erosion of a channel through the wetland, indicate that sediment trapping is not always an important function of these wetlands, except where regular overtopping of the channel occurs and flows spread across the full width of the wetland. Under low and medium flows, transport of sediment through, and out, of the system are more likely to be the dominant processes. Erosion may be both vertical and/or lateral and reflect the attempts of the stream to reach equilibrium with the imposed hydrology. From a functional perspective channelled valley bottom wetlands can play a role in flood attenuation when flows over top the channel bank and spread out over a greater width, with the surface roughness provided by the vegetation further slowing down the flood flows. These wetlands are considered to play only a minor role in the improvement of water quality given the short contact period between the water and the soil and vegetation within the wetland.

Un-channelled valley bottom wetlands reflect conditions where surface flow velocities are such that they do not, under existing flow conditions, have sufficient energy to transport sediment to the extent that a channel is formed. In addition to the biodiversity associated with these systems it is expected that they play an important role in retaining water in the landscape as well as in contributing to influencing water quality through for example mineralisation of rain water. These wetlands could be seen to play an important role in nutrient removal, including ammonia, through adsorption onto clay particles. The large size of the unchannelled valley bottom wetland associated with the Bronkhorstspruit suggests that this wetland plays an important role in flood attenuation – the temporary storage of flood waters within the wetland.

Pans/Depressions:

Given the position of many pans within the landscape, which is usually isolated from any stream channels, the opportunity for pans to attenuate floods is fairly limited, though some run-off is stored in pans. In the cases where pans are linked to the drainage network via seep zones, the function of flood attenuation is somewhat elevated. Pans are also not considered important for sediment trapping, as many pans are formed through the removal of sediment by wind when the pan basins are dry. Some precipitation of minerals and de-nitrification is expected to take place within pans, which contributes to improving water quality. Some of the accumulated salts and nutrients can however be exported out of the system and deposited on the surrounding slopes by wind during dry periods.

An important function usually performed by pans is the support of faunal and floral biodiversity, which is enhanced by the diversity in habitat types offered by different pans. Within the study area however, the small size of most of the pans, together with their seasonal nature and the disturbed vegetation, the biodiversity support of these pans individually is expected to be limited. All of the pans are seasonal or even ephemeral systems, though the differences in pan basin size and depth, as well as catchment size and catchment soil characteristics results in pans that fill up and drain at different rates and times. As a consequence, a great diversity of habitat is provided by the pans on site and in the surrounding area, and though they are all seasonal systems, the differing hydro periods result in the fact that at least some of the pans are likely to have water at any one time. The pans when seen as a complex of pan wetlands are thus of high importance in terms of biodiversity support, whereas if each pan is assessed in isolation, its importance in terms of biodiversity is limited.

4.3 Groundwater

4.3.1 Aquifer Characterisation

Four distinct aquifer types or hydrogeological units are present with the study area. These units vary by aquifer characteristics; however, the aquifers are generally interconnected by fractures and dolerite dykes (GCS, 2014).

- Shallow weathered Karoo aquifer: a shallow aquifer formed within the residual and weathered zone of the Karoo Supergroup, locally perched on fresh bedrock.
- Deeper fractured Karoo aquifer: a deeper aquifer formed by fracturing of the Karoo Supergroup and dolerite intrusions.
- Fractured dolomitic aquifer: a fractured aquifer hosted within the dolomite- and chert-rich Malmani Subgroup.
- Karst aquifer: an aquifer hosted within karstic dolomite, i.e. dolomite within which water has dissolved the soft rock along fractures, significantly increasing the size of fractures to form cavities.

Diamictite of the Dwyka Group is clay-rich and poorly sorted. Consequently, the rock has a lower permeability than overlying sandstone, and underlying fractured or karst dolomite aquifers, and is termed an aquitard. According to Sen (2015), an aquitard is a semipervious geological formation that transmits water at slower rates than an aquifer, with significantly lower yields than adjacent aquifers. The aquitard would influence the interconnectivity between overlying and underlying aquitards. Within the study area, interconnectivity between the Karoo and Malmani aquifers is likely limited, influenced by the occurrence and thickness of the Dwyka aquitard. The extent and connectivity of fracture networks within

rock of the Ecca Group, Dwyka Group and Malmani Subgroup, as well as the presence of dolerite dykes that have intruded across the geological formations, will also influence the interconnectivity of the aquifers and could result in localised zones of interconnection.

4.3.1.1 Shallow Weathered Karoo Rock Aquifer

Unconsolidated colluvium and weathered sediments overlie the consolidated formations. Underlying mudstone and siltstone bedrock often result in perched aquifer conditions. The depth of weathering generally ranges between 5 to 12 mbgl in the study area and receives relatively high recharge from rainfall (3% of MAP) (GCS, 2014). The water level of this perched aquifer is shallow and may daylight as springs occasionally when intersected by barriers such as topography, dykes and basement highs in valleys and topographic lows/depressions (GCS, 2014). The aquifer is relatively low yielding (0.01 – 0.14 l/s). As a result, groundwater is rarely abstracted from the aquifer. This aquifer is important as it often acts as a pathway for contaminants migrating from surface activities to surface water bodies such as rivers.

4.3.1.2 Fractured Karoo Rock Aquifer

The Vryheid Formation of the Ecca Group, Karoo Supergroup is characterised by thick sandstone and gritstone, alternated by sandy shale and coal beds. Most of the groundwater flow associated with mining will occur along the fractures, cracks and joints that are present within Karoo Sediments, and along contacts with dolerite intrusions. These conductive zones effectively interconnect the strata of the Karoo sediments, both vertically and horizontally into a highly heterogeneous and anisotropic unit.

The dolerite sill and dyke intrusions prevalent in the Karoo Supergroup and the study area generally act as aquitards and compartmentalize the groundwater regime. However fractured contact zones between the host rock and the intrusions often represent highly conductive groundwater flow paths. The horizontally and vertically extensive nature of the dolerite intrusions means that these conductive zones are interconnected and govern groundwater flows. The aquifer characteristics of these contact zones are heterogeneous. The boreholes where dolerite was intersected at shallow depths during drilling in 2014 did not encounter any water strikes (GCS, 2014).

The fractured Karoo aquifer can be classified as a minor (low yielding) aquifer system (Parsons, 1995) which displays variable yields and water quality. The Ecca Group is not known for the development of major aquifers, but occasional moderate - yielding boreholes may be present. This aquifer is reported to be approximately 40 m thick and exhibits characteristics of the intergranular and fractured regime (Barnard, 1999), which indicates that groundwater

storage and flow occurs mainly within the fractures of the rock. Dominant yield classes vary between 0.1 - 5.0 l/s.

4.3.1.3 Malmani Dolomitic Aquifer

The formation consists mainly of alternating layers of chert-free dolomite and chert-rich dolomite (Visser, 1989). The Dwyka Group of the Karoo Supergroup separates the dolomitic aquifer (targeted for water supply) from the overlying Vryheid Formation (mined for coal). The Dwyka tillite consists of gravelly diamictite with minor shale and mudstone that is less permeable than both the Vryheid Formation and the Malmani dolomite. The Dwyka is normally considered an aquitard (Woodford and Chevallier, 2002). Although the Dwyka aquitard can effectively limit the interconnection between the Karoo and Malmani (dolomitic) aquifers, localised zones of interconnection may exist at the contact with dolerite dykes, extensive fractures, sinkholes and boreholes that may have connected the aquifers.

An effective depth of 300m has been accepted as the maximum depth to which significant dissolution of the dolomite has taken place. A hydraulic conductivity that varies between 5 and 100m/day is considered representative of a karst aquifer. A karst aquifer has undergone dissolution of the soft rock along fractures, leading to significantly larger cavities for groundwater flow. Lower hydraulic conductivity and transmissivity values could be indicative of a fractured dolomitic aquifer that has not yet undergone significant kartsification.

The karst systems of the Malmani Subgroup are considered major aquifer systems which are normally high yielding and producers of good quality water (Barnard, 1999). High yields denote cavities associated with fracturing and jointing, and the groundwater yield is normally more than 5 l/s. The Malmani karst aquifer is a higher yielding resource for water supply than the overlying Karoo aquifers.

4.3.1.4 Aquifer Testing

Aquifer test results

A Hydrogeological Investigation was conducted by GCS is 2019/2020 and the full report can be found in Annexure B. Constant Rate (CR) and Recovery Tests (RT) were conducted on the production borehole WK-BH1 and reserve borehole WK-BH2. The pump inlet depth of borehole WK-BH1 could not be determined at the time of the site visit. WK-BH2 was tested by sub-contractors and available data was provided by the client and GCS for inclusion into the study. The borehole details are presented in Table 4.7.

Table 4.7 Aquifer Test Borehole Details

BH ID	Coordinates				

	Latitude	Longitude	Static Water Level	Pump Inlet Depth	Borehole Depth	Test Duration
[-]	[DD]	[DD]	[mbgl]	[mbgl]	[mbgl]	[hrs:min]
WK-BH1	-26.17330	28.71013	26.50	-	78	24:00
WK-BH2	-26.171994	28.719694	19.75*	123	127	12:00

Note/s:

[-]	-	not applicable	
[BH ID]	-	borehole identification	
[mgbl]	-	Metres below ground level	
[DD]	-	decimal degrees	
[m]	-	metres	
[hrs:min]	-	hours : minutes	

The aquifer test results are presented in Figure 4.5 and the details are summarised in Table 4.8. WK-BH1 was pumped at a constant rate of 20 L/s for 24 hours and a total drawdown of 11.42m was achieved. The borehole recovered to 90% of the original water level within 1 hour and 30 minutes with a total recovery of 100% reached after 3 hours and 30 minutes. The pipeline to the borehole was disconnected to measure the yield during pump testing. The water level was measured with an electronic water level logger (diver) during pumping and recovery.

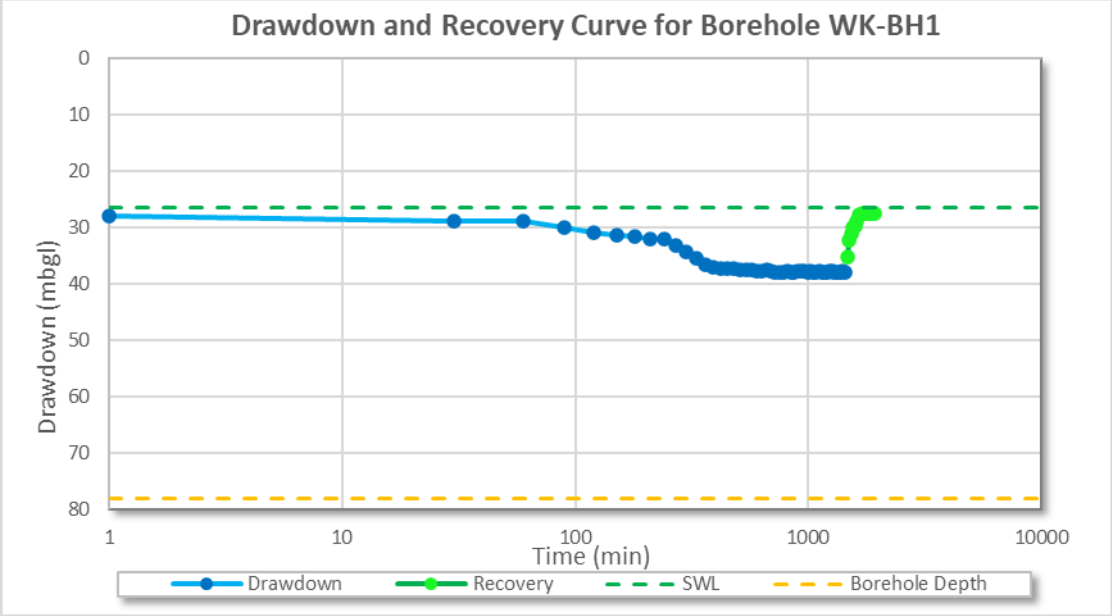


Figure 4.5 Drawdown and recovery curve for borehole WK-BH1

Borehole WK-BH2 was pumped for 12 hours and a total of 63.85m drawdown was achieved. The water level recovered to approximately 80% of the original water level within 3 hours. The results are presented in Figure 4.6 and summarised in Table 4.8.

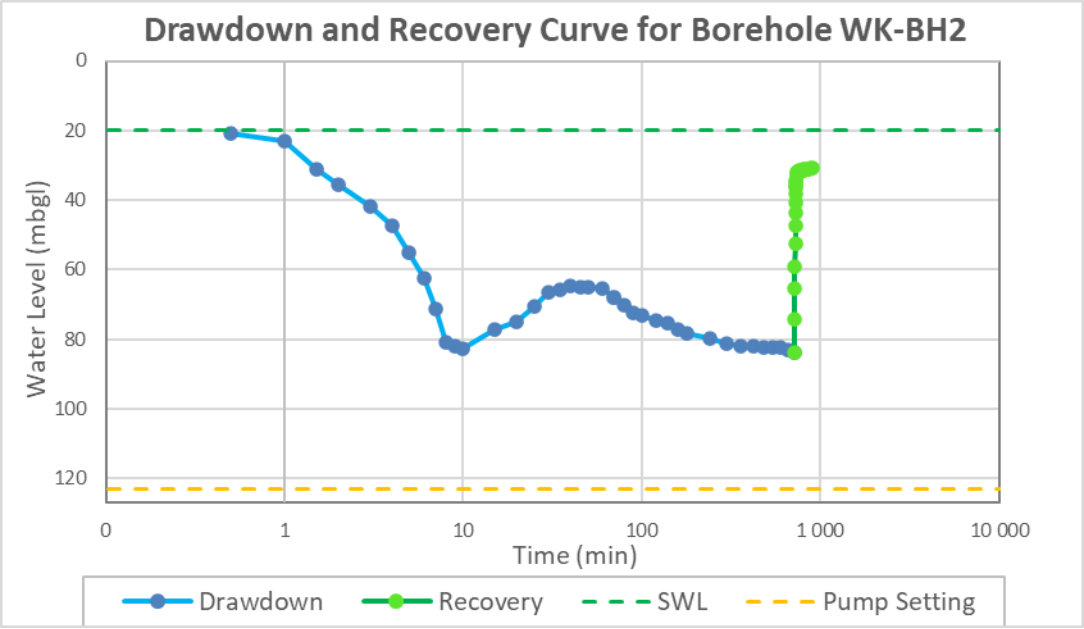


Figure 4.6 Drawdown and recovery curve for borehole WK-BH2

Aquifer parameters

The aquifer test data was analysed using the FC_EXCEL method and Wish 3.02.192c software. The FC_EXCEL software was developed by the Institute for Groundwater Studies, University of the Free State (Van Tonder et al. 2001). The Cooper Jacob straight line method was used to determine the transmissivity based on the drawdown data. The transmissivity is defined as the measure of the ease with which water will pass through the earth's material; expressed as the product of the average hydraulic conductivity and thickness of the saturated portion of an aquifer. The calculated transmissivity values are presented in Table 4.8 and Appendix B of Annexure B.

Table 4.8 Aquifer Test Results

BH ID	Total Recovery Duration	90% Recovery	Recovery	Total Drawdown	Pump Yield	Transmissivity
[-]	[hrs:min]	[%]	[%]	[m]	[l/s]	[m^2/day]
WK-BH1	08:00	01:30	100	11.42	20.00	355.7
WK-BH2	03:00	-	79.70	63.85	5.89	3.7

Note/s:

- [-] - not applicable
- [hrs:min] - hours : minutes
- [BH ID] - borehole identification
- [%] - Percentage
- [l/s] - litres / second

□ [m^2/day] - square meters per day

4.3.1.5 Recommended pumping schedule

Based on the aquifer test data, the recommended pumping schedule is summarised in Table 4.9.

WK-BH1 can be pumped at a yield of 8.37l/s for 20 hours (602.7m^3/day) and left to recover for 4 hours once pumping has stopped. Given this abstraction schedule a total volume of 602.74m^3/day can be abstracted from the borehole. This abstraction rate will achieve the plant's water requirement of 220 000m^3/annum. The pump inlet depth should be 75mbgl, if possible.

Borehole WK-BH2 should be pumped for no more than 12 hours per day at a yield of 2.31l/s (100m^3/day). The borehole should be given 12 hours to recover. This abstraction rate is informed by analytical modelling discussed in Section 4.3.5 and constitutes 17% of the water requirement. Although significantly lower than the plant water requirement, abstraction of WK-BH2 is only intended for reserve purposes and cannot be relied upon to fulfill the daily or yearly water requirement.

Table 4.9 Recommended Pumping Schedule

BH ID	Pump Depth	Pump Cycle	Recovery Time	Recommended Yield		
[-]	[mbgl]	[hrs]	[hrs]	[l/s]	[l/hr]	[l/d]
WK-BH1	75	20	4	8.37	30136.99	602739.73
WK-BH2	123	12	12	2.31	8 333.33	100 000

Note/s:
[-] - not applicable
[mbgl] - meters below ground level
[hrs] - hours
[l/s] - liters / second
[l/hr] - liters / hour
[l/d] - liters / day

4.3.2 Groundwater Quality

4.3.2.1 WK-BH1

Groundwater samples were collected from production borehole WK-BH1 and submitted to an accredited laboratory for inorganic analysis. The laboratory certificate is attached in Appendix A of Annexure B. The laboratory results were compared to the SANS 241-1:2015 drinking water quality standards (SABS, 2015).

From the table it can be seen that all general parameters, anions, cations and metals are compliant of the SANS241-1:2015 Standards.

Table 4.10 Groundwater Laboratory Results

Parameters	SANS 241-1: SANS 2015 Drinking Water Standard Limits	Sample ID
		WK-BH1
General Parameters		
pH at 22ºC (pH units)	≥5 to ≤9.7 [O]	8.2
Conductivity mS/m @ 25°C	≤170 [A]	61
Total dissolved solids (TDS)	≤1200 [A]	340
Total Alkalinity as $CaCO_3$	NS	169
Turbidity (NTU)	NS	150
Bicarbonate, HCO_3	NS	206
Carbonate, CO_3	NS	<12
Anions		
Chloride, Cl	≤300 [A]	58
Sulphate, SO_4	≤500 [AH]	73
	≤250 [A]	
Nitrate as N	≤11 [AH]	1.1
Nitrate as NO_3	≤50 [AH]	5
Nitrite as N	≤0.9 [AH]	<0.02
Nitrite as NO_2	≤3.0 [AH]	<0.05
Fluoride, F	≤1.5 [CH]	0.21
Cations and Metals		
Calcium, Ca	NS	42
Magnesium, Mg	NS	24
Sodium, Na	≤200 [A]	37
Potassium, K	NS	5.4
Iron, Fe	≤2 [CH]	<0.05
	≤0.3 [A]	
Aluminium, Al	≤0.3 [O]	<0.02
Manganese, Mn	≤0.4 [CH]	0.12
	≤0.1 [A]	
Boron, B	≤2.4 [CH]	0.088
Microbiological		
All parameters in mg/l unless specified otherwise		
Blue Shading: Exceedance in terms of SANS 241-1:2015 Drinking Water Standard		
[A] - SANS 241-1 Aesthetic Risk Limit		
[CH] - SANS 241-1 Chronic Health Risk Limit		
[AH] - SANS 241-1 Acute Health Risk Limit		

Parameters	SANS 241-1: SANS 2015 Drinking Water Standard Limits	Sample ID
		WK-BH1
[O] - SANS 241-1 Operational Risk Limit		
NS- No Standard		
NS- No Standard		

*Exceeds SANS 2015: Drinking Water Quality Standard

A piper diagram represents the chemistry of a water sample graphically from the WK-BH1. It is a tri-linear diagram that implements major cations calcium, magnesium, sodium and potassium) and anions (chloride, sulphate and bicarbonate) to reveal the chemistry of water samples. This is then used to characterise different types of water. The sample WK-BH1 analysed was a magnesium bicarbonate type with water plotting in the unpolluted groundwater region on the graph (refer to Figure 4.7). The piper diagram can also be used to verify if the groundwater is being contaminated by examining pollution trends (piper diagrams of groundwater samples over time).

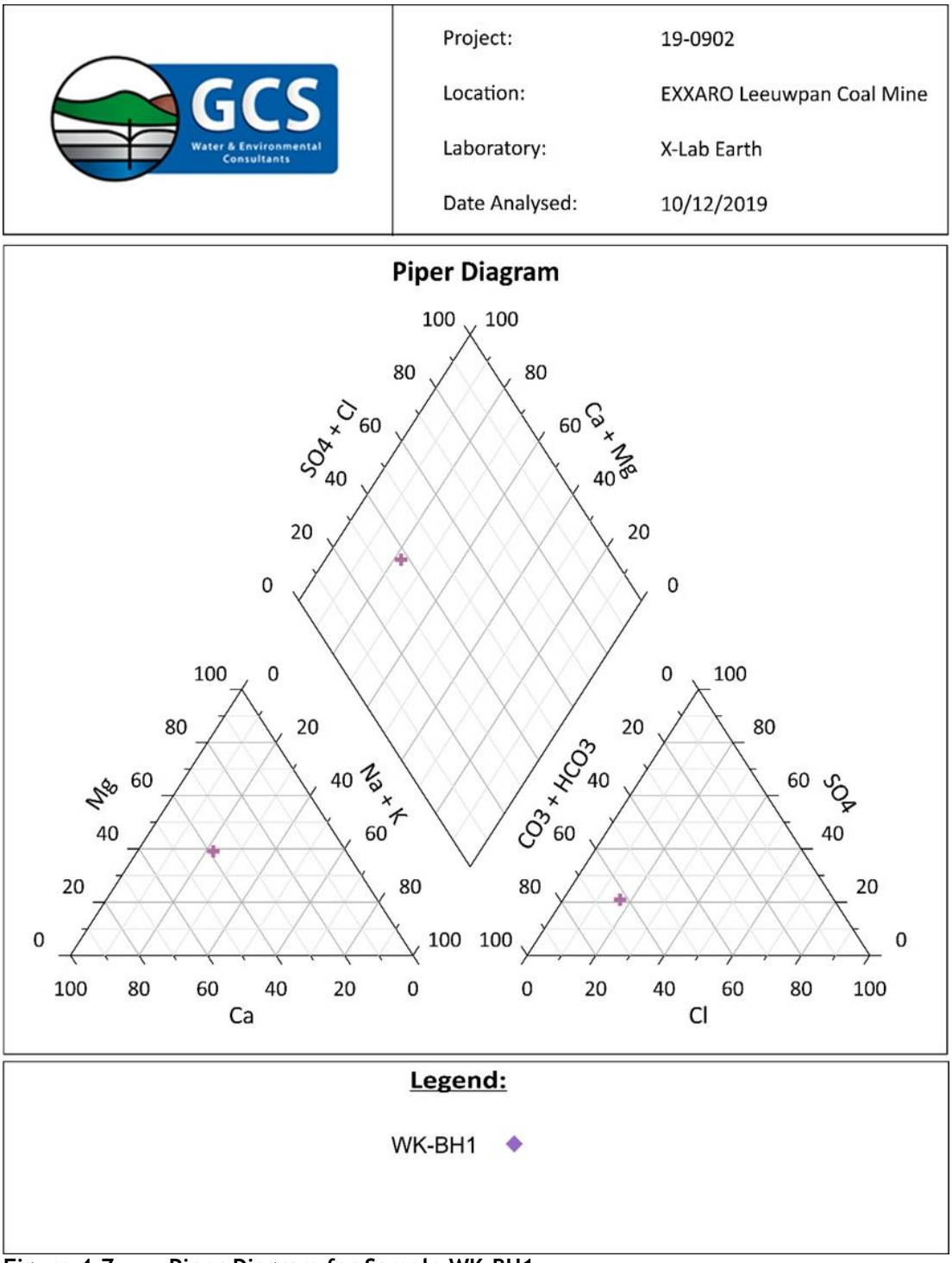


Figure 4.7 Piper Diagram for Sample WK-BH1

4.3.2.2 Overall Groundwater Quality of the Mine

The groundwater quality results were obtained from the Quarterly Water Quality Report conducted by Environmental Assurance (Envass) in September 2020 (Annexure H). Refer to Section 5.4.2 for the details pertaining to the groundwater monitoring points.

Groundwater monitoring was performed during September 2020 and twenty-two (22) borehole samples were obtained across the site.

Groundwater level depths typically vary between 1 and 54 meters below surface with the historical deepest level measured in monitoring borehole MOAMB9. The groundwater levels form boreholes MOAMB4 and RKL02 presents a water divide flowing towards the Bronkhorstspruit and the Bronkhorstspruit tributary.

The majority of the sampled localities recorded concentrations within the stipulated SANS 241-1:2015 limits presenting satisfactory conditions which included the following monitoring localities: WWN01, WELMB13S, RKL04, MOAMB4, MOAMB9, MOAMB10, WITMB14, WOLMB15S, LEEMB18S, WTN-02S and WTN01D. The remaining monitoring localities presented SANS 241-1:2015 exceedances summarised as follows:

- WELMB13D:
    - Sulphate (SO_4) and Manganese (Mn);
- LW07:
    - Fluoride (F), Iron (Fe), Manganese (Mn) and Ammonia (N);
- RKL01, LWG02:
    - Manganese (Mn);
- RKL02:
    - Ammonia (N);
- KENMB2S, KENMB3D, WOLMB15D, LEEMB18D:
    - Electrical Conductivity (EC), Total Dissolved Solids (TDS) and Sulphate (SO_4);
- MOAMB7:
    - Aluminium (Al); and
- WTN01S:
    - Sulphate (SO4) and Manganese (Mn);

According to the Expanded Durov Diagram (Figure 4.8) and associated Stiff Diagram (Figure 4.9); the September 2020 reveals that the majority of the aforementioned boreholes are dominated by calcium cations and sulphate anions. Based on the recorded results it is evident that impacts on the boreholes are present which is related to the mining operation.

According to Expanded Durov Diagram (Figure 4.8) and associated Stiff Diagram (Figure 4.9), the aquifer regime within the vicinity of the Exxaro Leeuwpan Mine is dominated by the following types of groundwater:

- Field 2: Fresh, clean, relatively young groundwater that has started to undergo Magnesium ion exchange, often found in dolomitic terrain.

- Field 4: Fresh, recently recharged groundwater with HCO_3 and CO_3 dominated ions that has been in contact with a source of SO_4 contamination or that has moved through SO_4 enriched bedrock.
- Field 5: Groundwater that is usually a mix of different types – either clean water from fields 1 and 2 that has undergone SO_4 and NaCl mixing/contamination or old stagnant NaCl dominated water that has mixed with clean water.

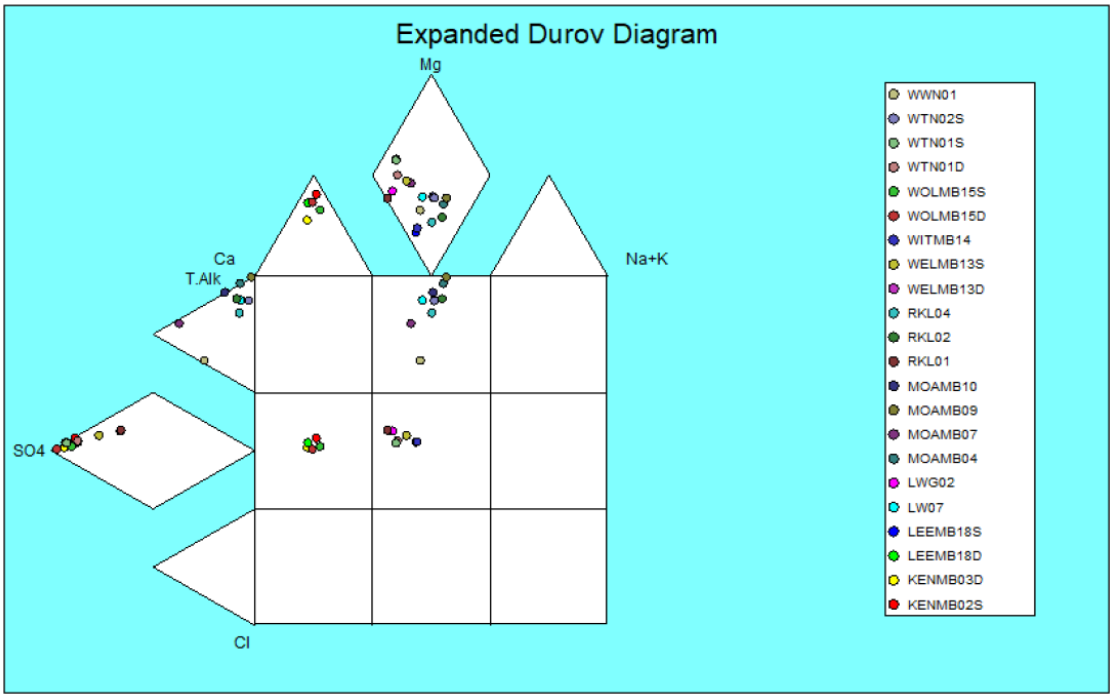


Figure 4.8 Expanded Durov diagram of groundwater chemistry regarding March 2020 (Envass, 2020)

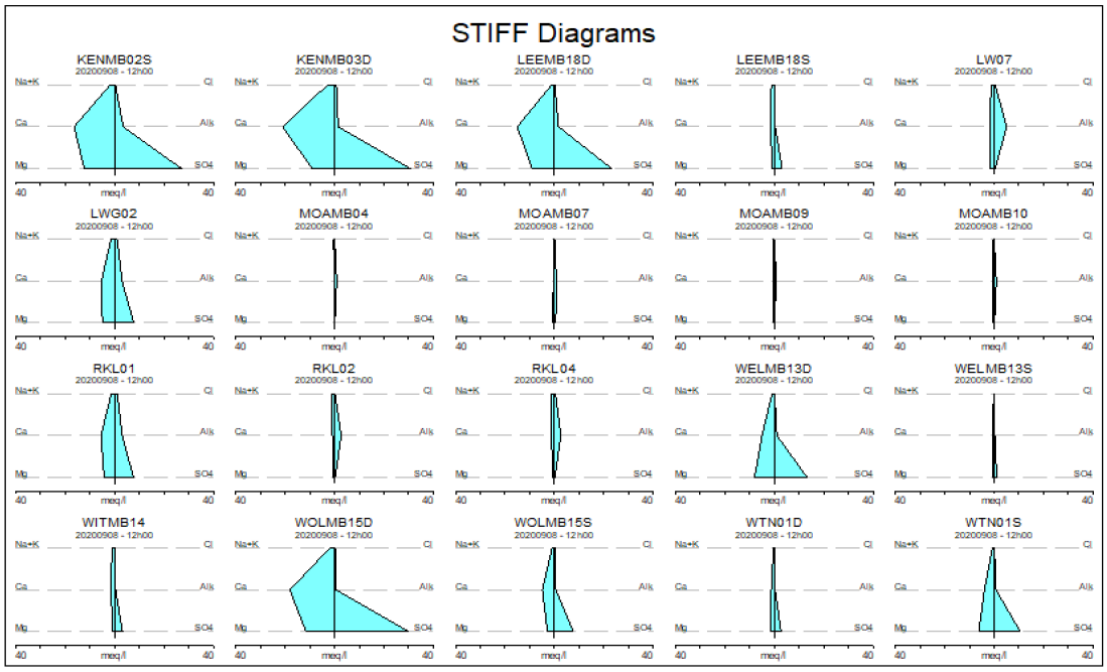


Figure 4.9 Stiff diagrams of groundwater chemistry regarding September 2020 (Envass, 2020)

4.3.3 Hydrocensus

A Hydrogeological Investigation was undertaken in 2019/2020 by GCS as part of this WULA and is attached as Annexure B to this report.

A hydrocensus was conducted by GCS within a 1km of the production borehole WK-BH1 and WK-BH2, on the 28th of November 2019. No production boreholes could be found abstracting groundwater from the aquifer system/s within the hydrocensus area, or within the sub-catchment containing the site. A number of monitoring wells are located within the vicinity of the mine and are presented in Figure 4.10.

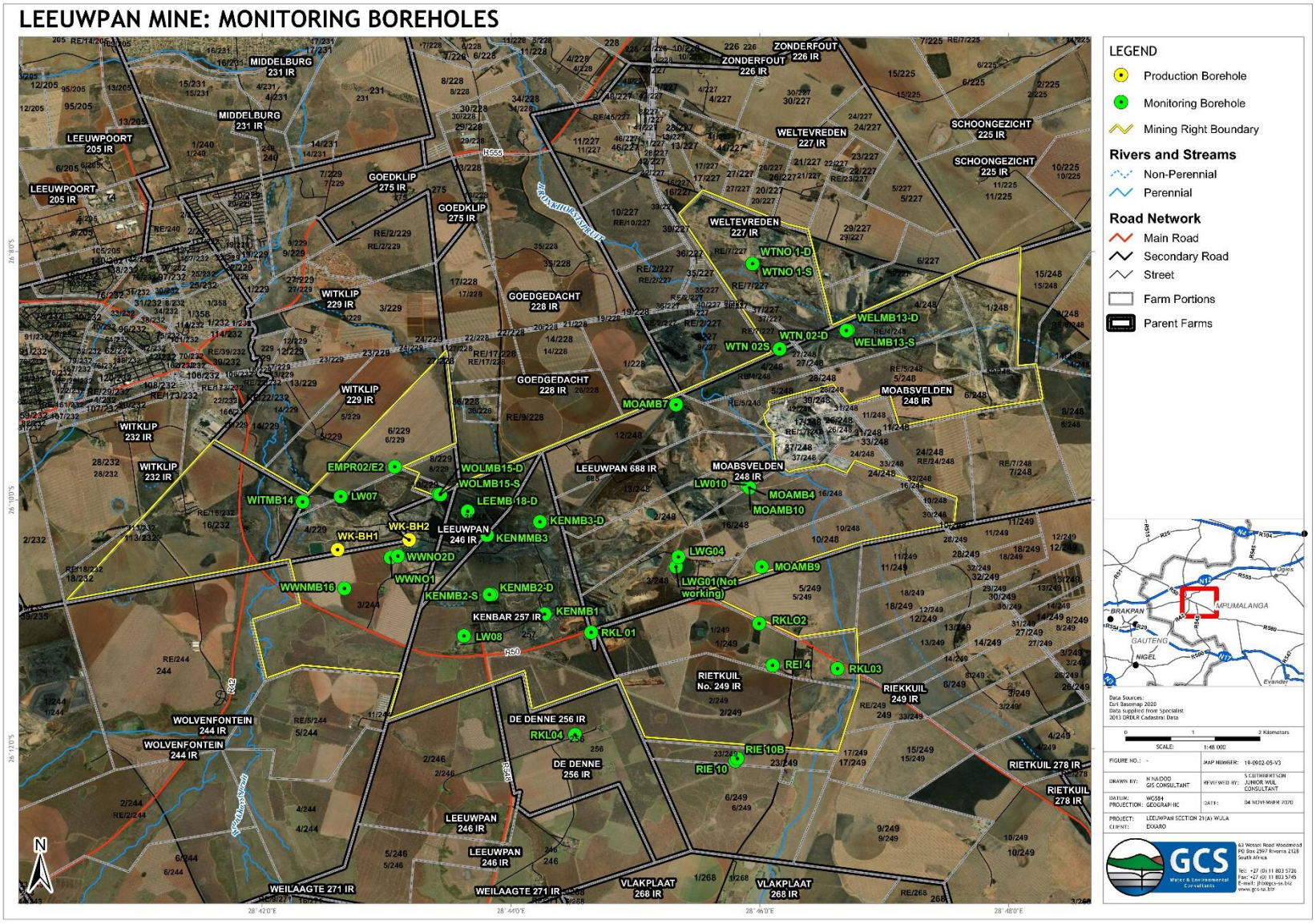


Figure 4.10 Monitoring Boreholes

4.3.3.1 Groundwater Reserve Determination

Quaternary Catchment

Data from relevant hydrogeological databases including, the Groundwater Resource Directed Measures (GRDM) was obtained from the DHSWS. The Delmas Dolomitic Compartment (DDC) falls within quaternary catchment B20A and B20B as seen in Figure 4.11. The quaternary catchment information is summarised in Table 4.11. A conservative value for recharge of 8.2% was used for the DDC, based on a previous study done by GCS (2012).

Table 4.11 Quaternary Catchment Details for Catchment B20A

Quaternary Catchment	Total Area	Recharge	Rainfall	Current use	Groundwater level
[-]	[km²]	[mm/a]	[mm/a]	[L/s]	[mbgl]
B20A	574.3	6.6	661.2	48.2	15.0
B20B	321.0	9.6	667.0	4.8	17.3

Note/s:

[-]	-	not applicable ▫
[km²]	-	square kilometres
[mm/a]	-	millimetre / annum
[L/s}	-	Litres / second
[mbgl]	-	meters below ground level

Sub-catchment Delineation

In order to delineate a sub-catchment within the quaternary catchment, ArcGIS was used (which provides a method to describe the physical characteristics of a surface). Using a digital elevation model as input, it is possible to delineate a drainage system and then quantify the characteristics of that system. The tools in the extension let you determine, for any location in a grid, the upslope area contributing to that point and the down slope path water would follow. This data is important during the numerical model boundary selection and impact assessment.

Dolomitic compartments are referred to when cross cutting dykes act as barriers to groundwater flow creating isolated hydrogeological compartments. The production borehole WK-BH1 and reserve borehole WK-BH2 is situated in the DDC (Meyer, 2014). The DDC in relation to the delineated sub-catchment is shown in Figure 4.11.

The recharge from a karst aquifer system is not only dependent on the recharge from within a sub-catchment.

Registered Abstraction

This registered abstraction volumes were made available by the Water Registration Management System (WARMS). This data was obtained in order to establish the scale of groundwater abstraction taking place within the DDC. The data can be seen detailed in Table 4.12. The total abstraction volume currently taking place from within the DDC is 22 616 062m^3/a. A Registered volume of 26 561 603 m^3/annum for the DDC is given by the WARMS database.

Table 4.12 WARMS Borehole Details for Quaternary Catchment B20A and B20B

Name	Latitude	Longitude	Register Status	WU Sector	Registered Volume
[-]	[DD]	[DD]	[-]	[-]	[m^3/a]
Quaternary Catchment - B20A					
24009396	-26.15947	28.77272	ACTIVE	MINING	360 000
24009396	-26.16053	28.77194	ACTIVE	MINING	900 000
24009396	-26.15753	28.77922	ACTIVE	MINING	1 692
24009396	-26.16369	28.77083	ACTIVE	MINING	5 438
24009582	-25.98515	28.58997	CLOSED	AGRICULTURE: IRRIGATION	190 020
24009591	-25.98515	28.58997	CLOSED	MINING	20 000
24011935	-26.26667	28.58997	ACTIVE	AGRICULTURE: IRRIGATION	872 400
24012783	-26.17000	28.76000	ACTIVE	AGRICULTURE: IRRIGATION	848 409
24014610	-26.01000	28.70000	ACTIVE	AGRICULTURE: IRRIGATION	19 000
24015414	-26.20000	28.76000	ACTIVE	AGRICULTURE: IRRIGATION	127 820
24015557	-26.16000	28.73000	CLOSED	AGRICULTURE: IRRIGATION	168 100
24015780	-26.02264	28.73686	ACTIVE	AGRICULTURE: WATERING LIVESTOCK	18 250
24016896	-26.15000	28.80000	ACTIVE	AGRICULTURE: IRRIGATION	2 735
24023316	-26.22000	28.69000	ACTIVE	AGRICULTURE: IRRIGATION	320 000
24024823	-26.17361	28.63500	ACTIVE	AGRICULTURE: IRRIGATION	24 000
24026108	-26.14790	28.74970	ACTIVE	INDUSTRY (URBAN)	100 000
24026377	-25.98515	28.58997	CLOSED	AGRICULTURE: IRRIGATION	46 480
24026974	-26.25000	28.76667	ACTIVE	AGRICULTURE: WATERING LIVESTOCK	56 700
24029016	-26.07000	28.71000	ACTIVE	INDUSTRY (NON-URBAN)	3 000
24029285	-26.23750	28.73194	ACTIVE	AGRICULTURE: IRRIGATION	90 200
24029347	-25.13020	28.77940	CLOSED	AGRICULTURE: IRRIGATION	3 390
24029962	-26.13000	28.72000	ACTIVE	AGRICULTURE: IRRIGATION	110 550
24030004	-26.69000	28.69000	CLOSED	AGRICULTURE: IRRIGATION	120 200
24030004	-25.98515	28.58997	CLOSED	INDUSTRY (NON-URBAN)	16 600
24031414	-26.17000	28.65889	ACTIVE	AGRICULTURE: IRRIGATION	12 000
24031423	-26.17361	28.64333	ACTIVE	AGRICULTURE: IRRIGATION	31 950
24031539	-26.18000	28.75000	ACTIVE	AGRICULTURE: IRRIGATION	511 280
24031744	-26.14000	28.73000	ACTIVE	AGRICULTURE: IRRIGATION	171 000
24031815	-26.12350	28.71020	ACTIVE	AGRICULTURE: IRRIGATION	160 000
24032681	-26.12000	28.74000	ACTIVE	AGRICULTURE: IRRIGATION	730 150
24033644	-26.17000	28.65972	ACTIVE	AGRICULTURE: IRRIGATION	28 000
24033653	-26.17361	28.66000	ACTIVE	AGRICULTURE: IRRIGATION	36 000
24033706	-26.16667	28.61667	ACTIVE	AGRICULTURE: IRRIGATION	1 448 000
24033779	-26.17083	28.65889	ACTIVE	AGRICULTURE: IRRIGATION	244 000
24033788	-26.14000	28.65000	ACTIVE	AGRICULTURE: IRRIGATION	597 600
24034377	-26.13333	28.61667	CLOSED	AGRICULTURE: IRRIGATION	14 210
24034509	-26.03382	28.58997	ACTIVE	AGRICULTURE: IRRIGATION	518
24034509	-26.03307	28.58997	ACTIVE	AGRICULTURE: IRRIGATION	1 440
24034509	-26.03291	28.58997	ACTIVE	AGRICULTURE: IRRIGATION	1 584
24035544	-26.03000	28.75000	ACTIVE	AGRICULTURE: IRRIGATION	9 560
24035624	-26.14000	28.74000	CLOSED	AGRICULTURE: IRRIGATION	290 800
24035688	-26.04360	28.67780	ACTIVE	AGRICULTURE: IRRIGATION	5 775
24035688	-25.98515	28.58997	ACTIVE	AGRICULTURE: IRRIGATION	28 780
24035731	-26.12130	28.67750	ACTIVE	AGRICULTURE: IRRIGATION	29 200
24041859	-25.98515	28.58997	ACTIVE	AGRICULTURE: IRRIGATION	31 530
24043045	-25.98515	28.58997	ACTIVE	AGRICULTURE: IRRIGATION	23 910
24046088	-26.14722	28.70639	CLOSED	AGRICULTURE: IRRIGATION	502 339
24046097	-26.09000	28.65417	CLOSED	AGRICULTURE: IRRIGATION	318 384
24046131	-25.98515	28.58997	CLOSED	AGRICULTURE: IRRIGATION	19 305
24049575	-26.07000	28.76000	ACTIVE	AGRICULTURE: WATERING LIVESTOCK	9 560

Name	Latitude	Longitude	Register Status	WU Sector	Registered Volume
24049682	-25.98515	28.58997	ACTIVE	AGRICULTURE: WATERING LIVESTOCK	2 000
24054265	-26.16583	28.66528	ACTIVE	AGRICULTURE: IRRIGATION	424 000
24054283	-26.17361	28.64333	ACTIVE	AGRICULTURE: IRRIGATION	34 200
24054309	-26.17361	28.63500	ACTIVE	AGRICULTURE: IRRIGATION	36 000
24054327	-26.17361	28.63500	ACTIVE	AGRICULTURE: IRRIGATION	24 000
24055442	-26.15000	28.62000	CLOSED	AGRICULTURE: IRRIGATION	1 825
24057191	-26.17000	28.76000	ACTIVE	AGRICULTURE: IRRIGATION	203 560
24057217	-26.16000	28.67000	ACTIVE	AGRICULTURE: IRRIGATION	858 945
24057379	-26.17000	28.65889	ACTIVE	AGRICULTURE: IRRIGATION	12 000
24057388	-26.17000	28.65889	ACTIVE	AGRICULTURE: IRRIGATION	28 000
24059135	-25.98515	28.58997	ACTIVE	MINING	20 000
24059135	-25.98515	28.58997	ACTIVE	MINING	24 000
24059135	-25.98515	28.58997	ACTIVE	MINING	68 400
24059135	-25.98515	28.58997	ACTIVE	MINING	26 400
24059135	-25.98515	28.58997	ACTIVE	MINING	15 360
24059135	-25.98515	28.58997	ACTIVE	MINING	15 360
24059135	-25.98515	28.58997	ACTIVE	MINING	120
24067199	-25.98515	28.58997	ACTIVE	AGRICULTURE: IRRIGATION	240 000
24073119	-26.16690	28.79110	ACTIVE	AGRICULTURE: WATERING LIVESTOCK	36 500
24079453	-26.19890	28.63530	CLOSED	AGRICULTURE: IRRIGATION	529 720
24080682	-25.98515	28.58997	ACTIVE	AGRICULTURE: IRRIGATION	10 320
24083947	-26.09000	28.65417	ACTIVE	AGRICULTURE: IRRIGATION	318 384
24084571	-26.15000	28.62000	ACTIVE	AGRICULTURE: IRRIGATION	9 000
24084651	-26.14722	28.70639	ACTIVE	AGRICULTURE: IRRIGATION	502 339
24089175	-26.16489	28.72242	ACTIVE	AGRICULTURE: IRRIGATION	46 480
24090902	-26.17333	28.69000	ACTIVE	AGRICULTURE: IRRIGATION	120 200
24090902	-25.98515	28.58997	ACTIVE	INDUSTRY (NON-URBAN)	16 600
24095756	-26.19764	28.67767	ACTIVE	MINING	324 000
24096283	-26.14000	28.74000	ACTIVE	AGRICULTURE: IRRIGATION	290 800
24097745	-26.14156	28.71750	ACTIVE	AGRICULTURE: IRRIGATION	103 680
24098575	-26.16000	28.73000	ACTIVE	AGRICULTURE: IRRIGATION	168 100
24098735	-26.22500	28.70028	ACTIVE	MINING	22 000
24098735	-26.22500	28.70028	ACTIVE	MINING	200 000
24099253	-26.13272	28.77411	ACTIVE	MINING	15 000
24099253	-26.13272	28.77411	ACTIVE	MINING	507
24099253	-26.13272	28.77411	ACTIVE	MINING	157 200
24099823	-26.12428	28.68050	ACTIVE	INDUSTRY (URBAN)	106 458
24099823	-26.12428	28.68050	ACTIVE	INDUSTRY (URBAN)	106 458
24099823	-26.12428	28.68050	ACTIVE	INDUSTRY (URBAN)	106 458
24100269	-26.11747	28.74819	ACTIVE	MINING	18 000
24100713	-26.16053	28.77194	COMPLETE	MINING	900 000
24100713	-26.16053	28.77194	COMPLETE	MINING	1 692
24100713	-26.16053	28.77194	COMPLETE	MINING	5 438
Quaternary Catchment - B20B					
24013185	-26.08000	28.63000	ACTIVE	AGRICULTURE: WATERING LIVESTOCK	9 000
24014736	-26.08000	28.52000	ACTIVE	AGRICULTURE: IRRIGATION	408 800
24015593	-26.08000	28.63000	CLOSED	AGRICULTURE: IRRIGATION	32 800
24015753	-26.19000	28.56000	ACTIVE	AGRICULTURE: IRRIGATION	324 950
24017047	-26.05000	28.50000	ACTIVE	AGRICULTURE: IRRIGATION	92 600
24017127	-26.02000	28.56000	ACTIVE	INDUSTRY (NON-URBAN)	9 560
24017225	-26.05000	28.49000	ACTIVE	AGRICULTURE: IRRIGATION	92 600
24017234	-26.04000	28.50000	ACTIVE	AGRICULTURE: IRRIGATION	92 600
24024039	-26.12111	28.58472	CLOSED	AGRICULTURE: IRRIGATION	73 600
24024878	-26.10000	28.61000	ACTIVE	AGRICULTURE: IRRIGATION	135 600
24026670	-26.03000	28.46000	ACTIVE	AGRICULTURE: IRRIGATION	320 000
24026689	-26.04120	28.55320	ACTIVE	AGRICULTURE: IRRIGATION	50 111
24026698	-26.04150	28.54960	CLOSED	AGRICULTURE: IRRIGATION	80 178
24026867	-26.04000	28.46000	ACTIVE	AGRICULTURE: IRRIGATION	640 000
24027456	-26.08000	28.61000	CLOSED	AGRICULTURE: WATERING LIVESTOCK	19 560
24027759	-26.00000	28.42507	ACTIVE	AGRICULTURE: IRRIGATION	45 610
24028847	-26.11930	28.63310	ACTIVE	AGRICULTURE: IRRIGATION	263 500
24028892	-26.75000	28.53333	ACTIVE	AGRICULTURE: IRRIGATION	98 270
24029882	-26.05170	28.49410	ACTIVE	AGRICULTURE: IRRIGATION	104 360
24029908	-26.12720	28.62470	ACTIVE	AGRICULTURE: IRRIGATION	661 000
24030362	-25.96786	28.67635	ACTIVE	AGRICULTURE: IRRIGATION	26 314
24030362	-26.11150	28.53850	ACTIVE	AGRICULTURE: IRRIGATION	51 300

Name	Latitude	Longitude	Register Status	WU Sector	Registered Volume
24030530	-26.06020	28.53050	ACTIVE	AGRICULTURE: IRRIGATION	66 735
24030585	-25.98060	28.64120	CLOSED	INDUSTRY (URBAN)	2 000
24030629	-25.96786	28.67635	CLOSED	AGRICULTURE: IRRIGATION	75 000
24031897	-26.10967	28.63588	ACTIVE	AGRICULTURE: IRRIGATION	90 520
24031913	-26.11030	28.62547	ACTIVE	AGRICULTURE: IRRIGATION	11 680
24031931	-26.01250	28.56290	ACTIVE	AGRICULTURE: WATERING LIVESTOCK	800
24031940	-26.02000	28.45000	ACTIVE	AGRICULTURE: IRRIGATION	163 500
24031968	-26.06410	28.50760	ACTIVE	INDUSTRY (URBAN)	73 000
24033813	-26.11000	28.64000	CLOSED	AGRICULTURE: IRRIGATION	71 400
24034117	-25.97760	28.63580	ACTIVE	AGRICULTURE: IRRIGATION	30 050
24035777	-25.96786	28.42507	ACTIVE	AGRICULTURE: IRRIGATION	29 200
24035802	-26.09000	28.61000	ACTIVE	AGRICULTURE: IRRIGATION	120 900
24035802	-26.09000	28.61000	ACTIVE	INDUSTRY (NON-URBAN)	1 848
24035866	-25.96786	28.42507	ACTIVE	AGRICULTURE: WATERING LIVESTOCK	14 600
24035964	-25.98990	28.59860	ACTIVE	AGRICULTURE: IRRIGATION	406 980
24036892	-26.16667	28.66667	ACTIVE	AGRICULTURE: IRRIGATION	80 400
24043081	-26.06000	28.50000	ACTIVE	AGRICULTURE: IRRIGATION	75 900
24043107	-26.00000	28.58000	ACTIVE	AGRICULTURE: WATERING LIVESTOCK	3 650
24043116	-26.04000	28.50000	ACTIVE	INDUSTRY (NON-URBAN)	1 825
24043125	-26.03000	28.47000	ACTIVE	AGRICULTURE: WATERING LIVESTOCK	1 190
24045882	-26.11014	28.62628	ACTIVE	AGRICULTURE: IRRIGATION	192 720
24046293	-26.15000	28.59000	ACTIVE	AGRICULTURE: IRRIGATION	513 450
24046300	-26.17000	28.56000	ACTIVE	AGRICULTURE: IRRIGATION	12 020
24046532	-26.10000	28.62000	ACTIVE	AGRICULTURE: WATERING LIVESTOCK	1 825
24049600	-26.01000	28.60000	ACTIVE	AGRICULTURE: WATERING LIVESTOCK	6 200
24049691	-25.96786	28.42507	ACTIVE	AGRICULTURE: IRRIGATION	2 860
24049726	-25.96786	28.42507	ACTIVE	AGRICULTURE: IRRIGATION	49 100
24050205	-26.11667	28.60833	ACTIVE	AGRICULTURE: IRRIGATION	49 883
24050401	-26.11500	28.54167	ACTIVE	AGRICULTURE: IRRIGATION	13 780
24053006	-25.96786	28.42507	ACTIVE	AGRICULTURE: IRRIGATION	66 420
24054871	-25.96786	28.42507	CLOSED	AGRICULTURE: IRRIGATION	164 457
24054899	-25.96786	28.42507	CLOSED	AGRICULTURE: IRRIGATION	279 160
24054924	-25.96786	28.42507	CLOSED	AGRICULTURE: IRRIGATION	86 950
24055086	-25.96786	28.42507	CLOSED	AGRICULTURE: IRRIGATION	34 300
24055139	-25.96786	28.42507	ACTIVE	AGRICULTURE: IRRIGATION	14 560
24055157	-25.96786	28.42507	ACTIVE	AGRICULTURE: IRRIGATION	21 140
24055317	-26.08861	28.59556	CLOSED	AGRICULTURE: IRRIGATION	237 276
24055335	-25.96786	28.42507	ACTIVE	AGRICULTURE: IRRIGATION	5 920
24059368	-25.96786	28.42507	CLOSED	AGRICULTURE: IRRIGATION	23 415
24067082	-25.96786	28.42507	ACTIVE	AGRICULTURE: IRRIGATION	143 800
24072334	-25.96786	28.42507	ACTIVE	AGRICULTURE: IRRIGATION	8 620
24074118	-26.10200	28.51600	ACTIVE	AGRICULTURE: IRRIGATION	266 640
24074733	-25.96786	28.42507	ACTIVE	AGRICULTURE: IRRIGATION	86 950
24075457	-25.96786	28.42507	ACTIVE	AGRICULTURE: IRRIGATION	16 576
24075475	-25.96786	28.42507	ACTIVE	AGRICULTURE: IRRIGATION	20 720
24075484	-25.96786	28.42507	ACTIVE	AGRICULTURE: IRRIGATION	24 864
24075493	-25.96786	28.42507	ACTIVE	AGRICULTURE: IRRIGATION	17 612
24075509	-25.96786	28.42507	ACTIVE	AGRICULTURE: IRRIGATION	22 792
24075518	-25.96786	28.42507	ACTIVE	AGRICULTURE: IRRIGATION	18 648
24075867	-25.96786	28.42507	ACTIVE	AGRICULTURE: IRRIGATION	110 144
24075876	-25.96786	28.67635	ACTIVE	AGRICULTURE: IRRIGATION	75 000
24076973	-26.08833	28.59611	CLOSED	AGRICULTURE: IRRIGATION	237 276
24076982	-26.08861	28.59556	CLOSED	AGRICULTURE: IRRIGATION	237 276
24079024	-26.05662	28.50350	ACTIVE	AGRICULTURE: IRRIGATION	28 000
24079024	-26.05275	28.50596	ACTIVE	AGRICULTURE: IRRIGATION	28 000
24079042	-25.96786	28.42507	ACTIVE	AGRICULTURE: IRRIGATION	372 300
24079168	-25.96786	28.42507	ACTIVE	AGRICULTURE: IRRIGATION	89 000
24079845	-25.96786	28.42507	ACTIVE	AGRICULTURE: IRRIGATION	279 160
24083279	-26.11586	28.62731	ACTIVE	AGRICULTURE: IRRIGATION	348 000
24084214	-26.08861	28.59556	ACTIVE	AGRICULTURE: IRRIGATION	237 276
24084223	-26.08833	28.59611	ACTIVE	AGRICULTURE: IRRIGATION	237 276
24084232	-26.08864	28.59556	ACTIVE	AGRICULTURE: IRRIGATION	237 276
24085106	-26.12111	28.58472	ACTIVE	AGRICULTURE: IRRIGATION	73 600
24087042	-26.19235	28.42478	ACTIVE	AGRICULTURE: IRRIGATION	164 457
24090225	-25.98750	28.66667	ACTIVE	AGRICULTURE: IRRIGATION	1 800
24090305	-26.08000	28.61000	ACTIVE	AGRICULTURE: WATERING LIVESTOCK	19 560

Name	Latitude	Longitude	Register Status	WU Sector	Registered Volume
24090626	-26.06372	28.51600	ACTIVE	AGRICULTURE: IRRIGATION	260 000
24090966	-26.01944	28.61733	ACTIVE	SCHEDULE 1	730
24090984	-26.03361	28.61750	ACTIVE	AGRICULTURE: IRRIGATION	21 000
24091830	-26.11433	28.51778	CLOSED	INDUSTRY (NON-URBAN)	5 770
24091830	-26.10753	28.53778	CLOSED	INDUSTRY (NON-URBAN)	10 950
24092214	-25.98060	28.64120	ACTIVE	INDUSTRY (URBAN)	2 000
24096265	-26.08000	28.63000	CLOSED	AGRICULTURE: IRRIGATION	32 800
24096595	-25.96786	28.42507	ACTIVE	AGRICULTURE: IRRIGATION	34 300
24098085	-25.98389	28.59803	ACTIVE	INDUSTRY (NON-URBAN)	18 000
24098085	-25.98389	28.59803	ACTIVE	INDUSTRY (NON-URBAN)	9 000
24099137	-26.04150	28.54960	ACTIVE	AGRICULTURE: IRRIGATION	80 178
24100125	-26.01896	28.54573	ACTIVE	AGRICULTURE: IRRIGATION	19 762
24100928	-26.08000	28.63000	ACTIVE	AGRICULTURE: IRRIGATION	32 800
24100937	-26.11000	28.64000	ACTIVE	AGRICULTURE: IRRIGATION	71 400
Active Volume for Quaternary Catchment - B20A					**13 589 990**
Active Volume for Quaternary Catchment - B20B					**9 026 072**
Total Active Volume					**616 062**
Total Volume					**26 561 603**

Note/s:

[-]	-	not applicable
[DD]	-	decimal degrees
[m^3/a]	-	cubic meters / annum
Coordinates	-	Projection: Geographic Datum: WGS84

Groundwater Balance

A groundwater balance was calculated for the sub-catchment containing the DDC. The DDC was delineated according to a WRC report from Meyer (2014). The delineated sub-catchment with the registered abstraction borehole localities can be seen in Figure 4.11.

Two water balance calculations were prepared for the DDC. The western half falls within quaternary catchment B20B (Table 4.14) with the eastern half falling within catchment B20A (Table 4.13).

A total of 83.4% of the groundwater recharge is being abstracted from the DDC. This includes the recommended daily abstraction volume of 602.74m^3/d from borehole WK-BH1. This abstraction is classified as a Class C abstraction given that more than 60% of the recharge is being abstracted. The abstraction volumes from borehole WK-BH2 is not included in this groundwater balance calculation. The borehole is only intended to be used for back-up purposes according to the client and will only be pumped if WK-BH1 cannot be abstracted.

Given the high volumes of abstraction from the DDC. It is recommended that the daily abstraction volume of 602.74m^3/d, not be exceeded.

Table 4.13 Groundwater Balance Calculation for quaternary catchment B20A containing the DDC

General Information	
Quaternary Catchment	B20A

Sub-Catchment				
Size			192.478708	km^2
			192 478 708	m^2
Groundwater Recharge			54.22	mm/a
			0.054218	m/a
	Sub Catchment Area	=	192 478 708	m^2
	Recharge per annum	=	10 435 888	m^3/a
	Recharge per day	=	28 591.5	m^3/day
Basic Human Need	GRDM		15.00	m^3/day
Abstraction Volumes	Hydrocensus Boreholes	=	26 181	m^3/day
	On Site Usage	=	603	m^3/day
	Existing Use from GRDM	=	4164.5	m^3/day
Groundwater Contribution to Baseflow			11.10	m^3/a
			0.03	m^3/day
Total Use			28252	m^3/day
Surplus Amount			339.50	m^3/day
Scale of Abstraction	99 % of recharge (Class C scale abstraction >60% of recharge)			

Table 4.14 Groundwater Balance Calculation for quaternary catchment B20B containing the DDC

General Information				
Quaternary Catchment			B20B	
Sub-Catchment				
Size			151.831292	km^2
			151 831 292	m^2
Groundwater Recharge			54.69	mm/a
			0.054694	m/a
	Sub Catchment Area	=	151 831 292	m^2
	Recharge per annum	=	8 304 261	m^3/a
	Recharge per day	=	22 751.4	m^3/day
Basic Human Need	GRDM		15.00	m^3/day
Abstraction Volumes	Hydrocensus Boreholes	=	15 147	m^3/day
	On Site Usage	=	-	m^3/day
	Existing Use from GRDM	=	414.7	m^3/day
Groundwater Contribution to Baseflow			6.05	m^3/a
			0.02	m^3/day
Total Use			15400	m^3/day
Surplus Amount			7 351.40	m^3/day
Scale of Abstraction	68			

		of recharge (Class C scale abstraction >60% of recharge)

Water quantity

The recent status of a groundwater resource unit can be assessed in terms of sustainable use, observed ecological impacts or water stress. Since no information about ecological impacts of groundwater abstraction is available, the concept of water stress was applied for the classification process.

The concept of stressed water resources is addressed by the National Water Act but is not defined. Part 8 of the Act gives some guidance by providing the following qualitative examples of 'water stress':

- Where demands for water are approaching or exceed the available supply;
- Where water quality problems are imminent or already exist; or
- Where water resource quality is under threat.

To provide a quantitative means of defining stress, a groundwater stress index was developed by dividing the volume of groundwater abstracted from a groundwater unit by the estimated recharge to that unit (Parsons and Wentzel, 2007).

Stress Index = Groundwater Abstraction / (Recharge – Baseflow)
= 21 825.99 / (25 671.44 – 8.58)
= **0.83**

Table 4.15 Guide for determining the level of stress of a groundwater resource unit

Present Status Category	Description	Stress Index
A	Unstressed or low level of stress	<0.05
B		0.05-0.2
C	Moderate levels of stress	0.2 - 0.5
D		0.5 - 0.75
E	**Highly Stressed**	**0.75 - 0.95**
F	Critically stressed	>0.95

Based on the theoretical stress index the aquifer (DDC) is under highly stressed.

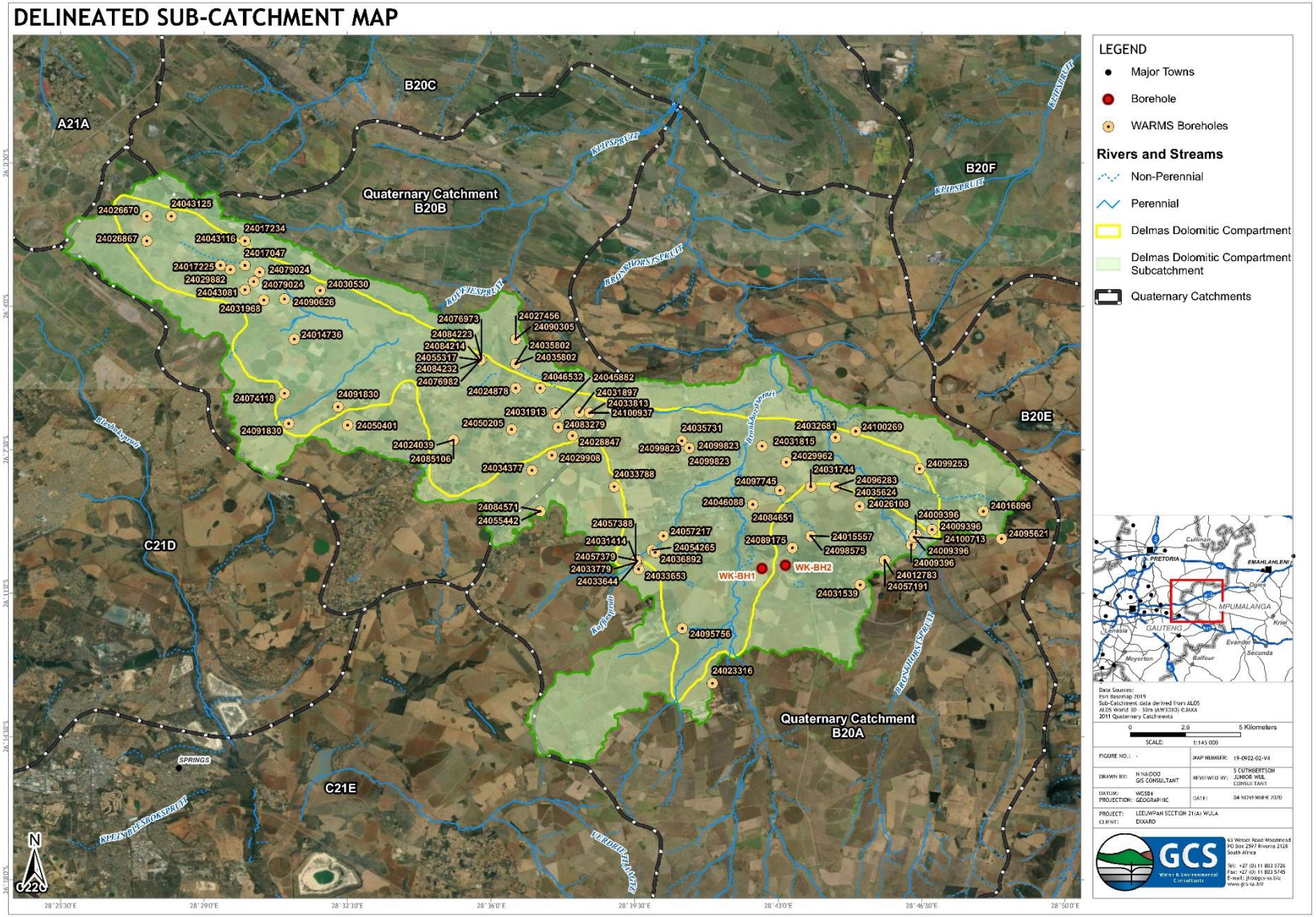


Figure 4.11 Delineated Sub-catchment with WARMS Boreholes shown on map

4.3.4 Potential Pollution Source Identification

Potential sources of groundwater pollution are present at Leeuwpan, as at any coal mining operation, due to the nature of the activity but is being managed. The pollution of groundwater is very likely in the event should water storage facilities not be adequately lined to prevent any ingress of dirty water into the groundwater regime. However, negative impacts on the groundwater regime can be minimised if the commitments stipulated in the various authorisations and licenses are adhered to.

Potential sources of groundwater pollution at Leeuwpan Coal include:

- All open pits;
- All stockpiles;
- All slimes dams, whether in use or not;
- Wash bays;
- All process water storage facilities;
- All domestic wastewater systems/installations;
- Water holding facilities associated with the Plant; and
- Evaporation dams.

4.3.5 Analytical Groundwater Model

The flow of water in an aquifer can be mathematically described by various partial difference equations. The equations can be solved by means of a mathematical model consisting of the applicable governing flow equation, equations describing the hydraulic head at aquifer boundaries, and initial head conditions in the aquifer. If the aquifer is homogenous and isotropic, and its boundaries can be described by algebraic equations, the mathematical model can be solved by use of analytical solutions based on integral calculus (Fetter, 2014). During abstraction from a borehole, drawdown of the head (groundwater level) within the aquifer occurs and a cone of depression forms in the aquifer. Drawdown at a specific distance from the well can be calculated with the use of analytical solutions. Steady groundwater flow within a confined aquifer occurs toward the well if there is a linear gradient to the potentiometric surface of the aquifer. The following assumptions apply (Fetter, 2014):

- The aquifer is bounded on the bottom by a confining aquifer.
- All geological formations are horizontal and have infinite horizontal extent.
- The potentiometric surface of the aquifer is horizontal prior to the start of pumping.
- The potentiometric surface of the aquifer is not changing with time prior to the start of pumping.
- All changes in the position of the potentiometric surface are due to the effect of the pumping well alone.

- The aquifer is homogenous and isotropic.
- All flow is radial toward the well.
- Groundwater flow is horizontal.
- Darcy's Law is valid.
- Groundwater has a constant density and viscosity.
- The pumping wells are fully penetrating, i.e. they are screened over the entire thickness of the aquifer.
- The pumping well has an infinitesimal radius and is 100% efficient.

Analytical modelling was conducted to assess abstraction from the production borehole WK-BH1 and the reserve (standby) borehole WK-BH2, which intersect dolomite of the Malmani Subgroup. It should be noted that abstraction of the boreholes was assessed independently, i.e. the impacts of concurrent abstraction were not assessed in this study.

4.3.5.1 Aquifer Parameters

Section 4.3.1.4 describes the transmissivity values derived from the pump tests of WK-BH1 and WK-BH2. Borehole logs and data pertaining to the screened intervals of the boreholes are not available. Therefore, the computed transmissivity could essentially be an indication of the cumulative transmissivity of the lithologies the boreholes have likely intersected, i.e. the Ecca Group and Dwyka Group of the Karoo Supergroup, and the Malmani Sub-group of the Transvaal Supergroup.

To incorporate the potential influence from the Karoo aquifer and the Dwyka aquitard, the following assumptions have been specified where applicable:

- An indicative depth of the overlying Karoo stratigraphy has been derived by assessing the coal floor contours or mine floor contours of mine blocks in proximity to the boreholes. These data files were provided by the client during the compilation of the numerical hydrogeological model in previous studies;
- Available borehole logs for monitoring boreholes that intersect the Karoo aquifer were also evaluated;
- The results of pump tests conducted for monitoring boreholes were assessed to derive a range of hydraulic conductivity values for the Karoo aquifer;
- Indicative thickness and hydraulic conductivity values of the Dwyka aquiclude were derived from the numerical hydrogeological model constructed and updated in recent years for Leeuwpan Coal Mine;
- The thickness of the Malmani Subgroup intersected by the two boreholes was estimated by subtracting the estimated thickness of the Karoo and Dwyka stratigraphy;

- Storativity values were derived from the numerical hydrogeological model and literature; and
- Indicative thickness, hydraulic conductivity, transmissivity and storativity values of the Karoo, Dwyka and dolomite are provided in Table 4.16.

Table 4.16 Parameters assigned to various lithologies in the analytical equations

Borehole WK-BH1				
Lithology	Thickness	Hydraulic Conductivity (K)	Storativity (S)	Transmissivity (T)
[-]	[m]	[m/day]	[-]	[m^2/day]
Karoo	23.40	0.30	2.00E-04	7.02
Dwyka	10.00	0.002	1.00E-05	0.02
Dolomite	44.60	7.82	2.23E-03	348.66
Cumulative Transmissivity			[m^2/day]	355.70
Borehole WK-BH2				
Lithology	Thickness	Hydraulic Conductivity (K)	Storativity (S)	Transmissivity (T)
[-]	[m]	[m/day]	[-]	[m^2/day]
Karoo	23.40	0.02	2.00E-04	0.47
Dwyka	10.00	0.002	1.00E-05	0.02
Dolomite	93.60	0.04	9.36E-04	3.41
Cumulative Transmissivity			[m^2/day]	3.90

4.3.5.2 Analytical Solutions

Predicted radius of influence

The maximum distance at which drawdown of groundwater levels can be detected with the usual measuring devices in the field is defined as the Radius of Influence (Dragoni, 1998).

The radius of influence can be calculated with the following equation:

$$Ro = \sqrt{(2.25xTx\frac{t}{S})}$$

(Equation 1)

Where,

Ro is the radius of influence (m)

T is the aquifer transmissivity (m^2/day)

t is time (day)

S is the storativity

The Radius of Influence (Ro) calculated for the two boreholes are presented in Table 4.17. The Radius of Influence is significantly larger for WK-BH1 than WK-BH2 due to a much higher (two-orders) transmissivity at WK-BH1. However, the Ro of WK-BH1 is largely constrained to

the Mining Right boundary and envelops the Karoo aquifer monitoring boreholes WWNMB16 and WWN01.

Table 4.17 Radius of Influence Calculations

Parameters	Description	Units	WK-BH1	WK-BH2
Ro	radius of influence	[m]	773.87	109.83
T	transmissivity	[m2/day]	355.70	3.90
S	storativity	[/]	0.0013	0.0007
t	time	[days]	1	1

Predicted drawdown

Two aquifer conditions should be considered for the dolomitic aquifer:

- The overlying Dwyka Group can confine the aquifer, restricting vertical groundwater flow to the underlying aquifer. Withdrawal from the well comes from the elastic storage of the aquifer alone (Sen, 2000). This necessitates the use of groundwater flow equations that describes groundwater flow in a confined aquifer; and
- However, the possibility that the Dwyka aquitard can slowly transmit water to the underlying dolomitic aquifer should also be considered. Withdrawal from the well would largely come from the elastic storage of the aquifer, but a component of flow from the aquitard would exist (Sen, 2000).

Both conditions were assessed analytically to provide an indicative range of drawdown after a day of abstraction from each borehole. It should be noted that each borehole has been allocated a daily groundwater level recovery period after abstraction.

<u>Confined Conditions</u>

The Thiem Equation was used to calculate drawdown at the well under confined conditions. The assumption that the aquifer is pumped at a constant discharge rate applies.

The Thiem Equation is described as follows:

$$T = Kb = \frac{Q}{2\pi(S_1 - S_2)} ln\left(\frac{r_2}{r_1}\right)$$

Where, *(Equation 2)*

T is the aquifer transmissivity (m^2/day)

K is the hydraulic conductivity of the aquifer (m/day)

b is the aquifer thickness (m)

Q is the discharge rate (m^3/day)

r_1 Distance from well (m)

r_2 Distance from well (m)

S_1 the groundwater level at r_1 (mbgl)

$S2$ the groundwater level at r_2 (mbgl)

This equation can be integrated with the following boundary conditions:

- At distance r_w (well radius) the head in a well is h_w
- At distance R from well (Radius of Influence), the head is H (undisturbed head and equal to the initial head before pumping).
- Sw is the groundwater level drawdown.
- The equation can be written as:

$$S_w = H - h_w = \frac{Q}{2\pi T} ln\left(\frac{R}{r_w}\right)$$

(Equation 3)

The predicted drawdown at the well calculated for each borehole is presented in Table 4.18. The abstraction rates proposed in Table 4.9 are applied in the calculations.

Table 4.18 Thiem Formula drawdown calculations for WK-BH1 and WK-BH2

Parameters	Description	Units	WK-BH1	WK-BH2
Sw	Drawdown	[m]	2.47	29.36
H	Head at Ro	[m]	0	0
hw	Head in well	[m]	-2.47	-29.36
Q	Discharge	[m^3/day]	602.74	100.00
T	Transmissivity	[m^2/day]	355.7	3.9
R	Radius of Influence	[m]	773.87	109.83
rw	Well radius	[m]	0.0825	0.0825

Groundwater level drawdown within the well could be approximately 3m at WK-BH1 and 30m at WK-BH2. By replacing the well radius with a specified distance of 1m from the well, a drawdown of 1.8 and 19mbgl is calculated for WK-BH1 and WK-BH2, respectively.

Semi-confined conditions

The Hantush-Jacob Method (1954) method was used to determine drawdown at various distances from the boreholes.

The following assumptions apply (Fetter, 2014):

- The aquifer is bounded on the top by an aquitard. The thickness of the aquitard is denoted by a *b'*, its hydraulic conductivity by *K'* and storativity by *S';*

- The aquitard is overlain by an unconfined aquifer known as the source bed. The thickness of the source bed is denoted by a *b"*, its hydraulic conductivity by *K"* and storativity by *S";*
- The water table in the source bed is initially horizontal; and
- The water table in the source bed does not fall during pumping. This assumption was not met and is difficult to attain unless there is continuous recharge to the source bed. The following equations were utilised to determine whether this assumption applies:

$$t < \frac{S'(b')^2}{10bK'}$$

Where, *(Equation 4)*

t time since pumping began (days)

S' Storativity of the aquitard (dimensionless)

b' Thickness of the aquitard (m)

b Thickness of the confined aquifer (m)

K' Vertical hydraulic conductivity of the aquitard (m/day)

$$b"K" > 100bK$$

Where, *(Equation 5)*

b" Thickness of the source bed (m)

K" Hydraulic conductivity of the source bed (m/day)

b Saturated thickness of the confined aquifer (m)

K Hydraulic conductivity of the aquifer (m/day)

The results of the testing of this assumption are presented in Table 4.19.

Table 4.19 Equation 4 and 5 Calculations

Equation 4	**Units**	**WK-BH1**	**WK-BH2**
b"K"	[m^2/day]	7.02	0.468
100bk	[m^2/day]	34866	341.2
Equation 5	**Units**	**WK-BH1**	**WK-BH2**
t	[day]	1	1
$(S'(b')^2)/(10*b*K')$	[day]	1.12E-03	5.34E-04

- Groundwater flow in the aquitard is vertical.
- The aquifer is compressible, and water drains instantaneously with a decline in head.
- The aquitard is incompressible, so that no water is released from storage in the aquitard when the aquifer is pumped. The assumption is met based on the application of the following equation.

$$t > 0.036b'S'/K'$$

Where, *(Equation 6)*

t time since pumping began (days)

S' Storativity of the aquitard (dimensionless)

b' Thickness of the aquitard (m)

K' Vertical hydraulic conductivity of the aquitard (m/day)

The results of the testing of this assumption are presented in Table 4.20.

Table 4.20 Equation 6 Calculations

Equation 6	Units	WK-BH1	WK-BH2
t	[day]	1	1
0.036b'S'/K'	[day]	1.80E-03	1.80E-03

- The radius of the well is negligible. The assumption is met based on the application of the following equation.

$$t > (30{r_w}^2 S/T)[1 - (10r_w/b)^2]$$

Where, *(Equation 7)*

t time since pumping began (days)

r_w radius of the pumping well (m)

S Storativity of the confined aquifer (dimensionless)

T transmissivity of the confined aquifer (m^2/day)

b Thickness of the confined aquifer (m)

$$r_w/(Tb'/K')^{1/2} < 0.1$$

Where, *(Equation 8)*

r_w radius of the pumping well (m)

K' hydraulic conductivity of the aquitard (m/day)

T transmissivity of the confined aquifer (m^2/day)

b' Thickness of the aquitard (m)

The results of testing of this assumption are presented in Table 4.21.

Table 4.21 Equation 7 and 8 Calculations

Equation 7	Units	WK-BH1	WK-BH2
t	day	1	1
$(30r_w^2S/T)(1-(10r_w/b)^2$	day	1.31E-06	5.60E-05
Equation 8	**Units**	**WK-BH1**	**WK-BH2**
$r_w/(Tb'/K')^{1/2}$	/	2.71462E-14	2.83463E-10

The Hantush-Jacob formula is described as follows:

$$h_0 - h = \frac{Q}{4\pi T} W(u, r/B)$$

Where, *(Equation 9)*

h_0-h	drawdown in the confined aquifer (m)
Q	the pumping rate (m^3/day)
T	transmissivity of the confined aquifer (m^2/day)
W(u,r/B)	leaky artesian well function (values tabulated in Fetter (2014)

$$u = \frac{r^2 S}{4Tt}$$

Where, *(Equation 10)*

r	distance from the pumping well (m)
S	storativity of the confined aquifer (dimensionless)
T	transmissivity of the confined aquifer (m^2/day)
t	time since pumping began (days)

$$B = (Tb'/K')^{1/2}$$

Where, *(Equation 11)*

B	leakage factor (m)
b'	thickness of the aquitard (m)
K'	hydraulic conductivity of the aquitard (m/day)

The results of the drawdown calculations for WK-BH1 and WK-BH2 using the Hantush-Jacob formula are presented in Table 4.22 and Table 4.23, respectively. The abstraction rates proposed in Table 4.9 are applied in the calculations.

Table 4.22 Hantush-Jacob Formula drawdown calculations for WK-BH1

r	u	r/B	W (u, r/B)	h_0-h
[m]	[-]	[-]	[-]	[m]
1	1.60E-06	7.57E-04	12.40	1.71
10	1.60E-04	7.57E-03	7.86	1.08
100	1.60E-02	0.0757	3.28	0.45
500	0.40	0.3787	0.67	0.09
773.87	0.96	0.5861	0.206	0.03

Table 4.23 Hantush-Jacob Formula drawdown calculations for WK-BH2

r	u	r/B	W (u, r/B)	h_0-h
[m]	[-]	[-]	[-]	[m]

1	6.86E-05	7.66E-03	8.75	20.41
10	6.86E-03	7.66E-02	4.20	9.80
109.83	8.27E-01	8.41E-01	0.27	0.64
200	2.74	1.531230187	0.01	0.02

There is a good correlation between the results of the drawdown calculations under semi-confined and confined conditions. At 1m from each well, the predicted drawdown ranges between 1.7 – 1.8m and 19 – 20m, respectively. At approximately 100m from the boreholes, predicted drawdown could be 0.5 and 0.6m, respectively, after a day of abstraction.

4.3.6 Acid Mine Drainage Plan

Acid mine drainage (AMD) also known as acid rock drainage (ARD) is a well-defined process where sulphide minerals (mainly pyrite) are oxidized to produce acidic leachate. This reaction is a two-step process where the first reaction results in sulphuric acid and ferrous sulphate, then with further oxidation ferric hydroxide and more sulphuric acid is formed. Pyrite is a common minor constituent in many mineral deposits, such as coal.

In the natural environment this reaction takes place at a very slow rate and as a result naturalisation almost always removes the acidity. Mining activities disturb the in-situ rocks and expose pyrite, which accelerates the oxidation reaction.

4.3.6.1 Site Characterisation and Field Work

An AMD management strategy should consist of the following actions:

- **Development of a site specific conceptual model**. This model will describe the following:
    - Conceptualize the source – Identify all geological units that are disturbed during mining? Determine which of these units are potential acid forming?;
    - Conceptualize the pathway – What is the most likely pathway for contaminants to migrate off site and reach potential receptors (surface or groundwater); and
    - Identify the receptors – identify all potential current and future receptors.
- **Sample selection**. Based on the conceptual model a sample plan should be developed to get information of the disturbed geological units (geochemical analyses) as well as the surface and groundwater quality. The sample plan will determine which materials and locations needs to be sampled.
- **Test work** (as described below).

Test Work

Geochemical test work to predict AMD consists of the following:

- Static testing, such as Acid Base Accounting (ABA). Static test gives an indication of the overall potential that a rock sample will generate acidic leachate. It determines the balance of acid generating and acid neutralizing capacity of a sample. This is a relatively low-cost procedure which can be done in a matter of hours to a few days.
- Kinetic testing, such as humidity cell tests attempt to predict the quality of the leachate over time. Rocks / samples with a net acid generating potential will be subjected to kinetic test. Kinetic test is defined as a group of test work procedure wherein acid generation and metal mobilization from a sample is measured over time. These procedures could take up to 26 weeks to complete.

Field trails are set up as large-scale column leach tests on the sites – under actual field conditions. Laboratory tests need to be converted to field conditions and the best way of "calibrating" the lab results are with field trails.

4.3.6.2 Acid Mine Drainage Management Plan for Leeuwpan Mine

The following Acid Mine Drainage management plan has been developed for Leeuwpan Mine:

- A review of geological units that are disturbed during mining has been done. The geological database was used to develop conceptual geochemical units of all the disturbed lithologies.
- Geochemical units have been sampled and submitted for static test work.
- Samples from geological units that are potentially acid forming have been submitted for kinetic test work.
- Field trails have been set up on the mine with potentially acid forming samples.
- Review all surface and groundwater chemical data with reference to acidic leachate is done on a continuous basis.
- Once the results of the field trials are available, a geochemical report will be produced which will make proposals for the handling and disposal of potentially acidic materials. This report will also inform closure scenario selections for the various mining voids.

4.4 Socio-Economic Environment

The social baseline of the Socio-Economic environment has been assessed and determined for this application. The information in this section was taken from the 'Victor Khanye Local Municipality Final Integrated Development Plan 2019/20 Review'.

4.4.1 Regional Context

Mpumalanga literally means "the place where the sun rises". Mpumalanga lies in eastern South Africa, north of KwaZulu-Natal and borders Swaziland and Mozambique. In the north it

borders on the Limpopo Province, while to the west it borders on the Gauteng Province, to the southwest it borders on the Free State Province and to the south the KwaZulu-Natal Province. The capital is of the Province is Mbombela (previously known as Nelspruit).

Mpumalanga Province is divided into three District Municipalities (DM), which are further subdivided into 17 Local Municipalities (LM). The DMs for the Mpumalanga Province are provided below:

- Gert Sibande DM;
- **Nkangala DM;** and
- Ehlanzeni DM.

The Nkangala DM is divided into the following LM:

- Emalahleni LM;
- Thembisile Hani LM;
- Dr JS Moroka LM;
- Steve Tshwete LM;
- **Victor Khanye LM; and**
- Emakhazeni LM

4.4.2 Local Context

Victor Khanye LM (formerly Delmas Local Municipality) is located in the Western Highveld of the Nkangala DM. The Victor Khanye LM's boasts a growing economy, with the trade sector, agriculture and mining sector forming the cornerstones of the economy. Mining activities within the LM are currently concentrated on coal and silica. Agriculture is, however, the main source of employment in the area and is growing constantly.

The Victor Khanye LM consist the following main places:

- Delmas;
- Botleng;
- Delpark;
- Eloff; and
- Sundra

4.4.2.1 Demographic profile

According to Stats SA (2016 community survey), Victor Khanye municipality's population has grown from 75 452 to 84 151 in 5 years. This recorded a growth rate of 2.5% per annum between 2011 and 2016. By 2030, population growth is estimated at 118 903 given the historic population growth per annum, indicative of the migration of labour attracted to the area as

a result of the potential for economic growth and resultant job opportunity. The municipality has the 3rd smallest population in Mpumalanga province and 5.8% of total population of Nkangala.

Population Distribution:

The municipality has recorded a significant growth in the number of household units from 12 478 in 1996, 20 548 in 2011 to 24 276 in 2016, representing an increase of 53% as a result of the population's exponential growth. However, the Victor Khanye Local Municipality comprises only 5.8% of the total households in the Nkangala District Municipality by implication that indicates that the municipality should provide services to more household. Table 4.24 indicates the number of female and male household heads.

Table 4.24 Head of household by sex (adult: above 18 years old) (Stats SA, 2016)

Year	2016
Male	16 707
Female	7 506

Unemployment

Unemployment level has been reduced from 28.2% to 21.6% in terms of Global Insight figures. This reduction is a results of an increase in investments in our local economy. The employment situation is expected to improve over the medium term with additional jobs expected in the mining sector. The latest statistic reflects that the employment level in the Victor Khanye Local Municipality is currently at 28.9%. Based on the 2016 definition of Economically Active Population (EAP) of 30 415, the unemployment rate is reflected at 21.6%, this represents an overall gain in employment compared to 2011. This figure is high when we consider the economic activity in the area, but obviously impacted by the migration influx of job seekers. Leading industries in employment comprise of Trade (18.7%), Agriculture (18.2%) and Community Services contributing (14.3%). However, the former two sectors are experiencing a decline in employment in the last few years whilst Community Services has increased and Mining as an employer has grown and now contributes 12.7%.

Income Distributions

The income level per household is considered a better barometer of poverty and reflects that 42% can be classified as Indigent as they earn less than R1 600 per month, as per Stats SA 2016. Not all these households have registered to qualify for access to free basic services as provided in the Indigent Policy guidelines. This issue is currently being progressed by the municipal administration. There is a negative trend developing as more households are reportedly below the poverty line. The average household income level in the Victor Khanye

Local Municipality areas is reflected as R80 239 per annum, ranking it 9th with respect to the overall province statistics standing.

Education

Outcome 1 of the Delivery Agreement requires the improvement of the quality of basic education in general and in Maths and Science in particular. The Victor Khanye Local Municipality has an inherited problem namely that the low-income levels per household in the community correlate to the low education levels in the area. The 2016 Survey shows that 25% of the population above 15 years of age has had no schooling or did not complete primary school. Of this number, 5 528 are basically illiterate and therefore, future meaningful employment prospects are virtually impossible. A further 41% of the population did not complete the schooling curriculum and therefore, did not reach the level of matric.

Matriculates wrote the year-end exam, which reflects an upward trend and attributed to Victor Khanye Local Municipality being ranked in 5th place in the province. However, this improved pass rate was not reflected in the university admission rate with only 26.2% of scholars seeking to further their education status. When these statistics are compared with the unemployment statistics, the assumption can be made that a high percentage of job seekers do not have the minimum education entry level. Unfortunately, these job seekers will be restricted to unskilled manual work where the main employer in this sector of employment, namely agriculture, is receding as a leading employer. This poses a huge problem within the communities as the dependency syndrome increases and criminal activities increase.

The status of teacher and pupil ratio in the township schools are slowly creating a problem for public education in Delmas. The Primary schools in Botleng Proper are experiencing a decline in learner registration. These phenomena might be influenced by the development of Botleng Extension 3, 4 and 5 versus the ageing of the population in Botleng Proper. Contrary to this declining trend, the Primary schools in Botleng Extension 3 are experiencing overcrowding. Secondary schools are not much affected by this situation because these pupils are more mobile and able to commute between the different areas. With the Development of Botleng extension 6 the problem will be exacerbated even further. There might be a future need for transportation for learners to fill the empty schools. The following table illustrates the attendance levels at the various Educational Institutions by Ward.

4.4.2.2 Infrastructure and Service Delivery

Water and Sanitation

The bulk provision of water in the urban area of the Victor Khanye Local Municipality is accessed from two sources: subterranean water via a number of boreholes as well as Rand Water. The various boreholes provide water for the Botleng, Delmas and Delpark areas whilst Rand Water is provided in the Sundra and Eloff areas. Approximately 40 000 consumers in the urban areas of the municipality are supplied from subterranean water sources by means of boreholes (from 4 borehole fields and 15 operational boreholes). What has become evident, was that of the (then) 24 276 households in the Victor Khanye Local Municipality, 20 897 (86%) households (86 %) have piped potable water on their stands.
All stands in the Victor Khanye Local Municipality, excluding those in the Eloff and Sundra areas (which piped potable water), are connected to a water-borne sanitation system. The water and sanitation services are therefore, very closely linked to one another. The Water Services Development Plan referred to under the water service above also addresses the sanitation service and is therefore, also applicable in this regard. Those stands that are not connected to the water-borne sanitation system use septic tanks.

Despite the fact that sanitation includes wastewater treatment, the two terms are often use side by side as "sanitation and wastewater management". The term sanitation has been connected to several descriptors so that the terms sustainable sanitation, improved sanitation, unimproved sanitation, environmental sanitation, on-site sanitation, ecological sanitation, dry sanitation is all in use today. Sanitation should be regarded with a systems approach in mind which includes collection/containment, conveyance/transport, treatment, disposal or reuse.

Electricity and Street Lighting

Of the 24 276 households in the Victor Khanye Municipality, 22 324 (92%) households use electricity for lighting purposes. These figures translate to an electricity backlog of at least 1 946 households.

The Victor Khanye Local Municipality services Delmas and parts of Botleng and its Extensions. The other areas of Eloff, Sundra, Rietkol, Botleng Ext. 3 and the rural areas receive electricity directly from Eskom and therefore, do not fall under the municipalities billing system, but require to be upgraded to ensure that communities receive uninterrupted services. The electricity network within Victor Khanye Local Municipality is ageing and has become inefficient. The main electricity substation is under severe pressure and needs to be upgraded since the electricity demand is increasing due to developments both in the residential, commercial and industrial sectors. The infrastructure within the area supplied by Eskom (Eloff, Sundra, Botleng and Extension 3) needs to be upgraded to ensure that communities receive uninterrupted services. The advent of Pre-paid electricity metering has significantly

improved revenue collection and this coupled with the 50/50 system of credit and arrears payment through card purchases is enabling the municipality to reduce the outstanding debtor base.

Roads and Stormwater

Various national, provincial and municipal roads run through the Victor Khanye Local Municipality, with many regional routes converging at Delmas which lends it strategic significance. Consequently, the Municipality features a well-developed regional road and rail infrastructure. The N12 national toll road that links Johannesburg with Nelspruit runs from east to west through the northern part of the municipality. This road also links the Municipality with the Maputo Development Corridor.

The major provincial roads in the municipal area are:

- R50 that links Tshwane with Standerton;
- R43 that links with Bronkhorstspruit;
- R555 that links Springs with Witbank; and
- R548 that links with Balfour; and R42 that links with Nigel.

Local Activity Corridors identified include:

- Sarel Cilliers Street/ Witbank Road in Delmas (R555);
- The Avenue – Eloff Town;
- Main Road – Rietkol Agricultural Holdings; and
- Samuel Road and Van der Walt Street – Delmas; and Dr Nelson Mandela Drive – Botleng.

Waste Removal

Refuse is removed in most of the Botleng areas twice a week and in Delmas, Sundra and Eloff once a week. In Sundra, Delmas and Eloff, refuse is removed through the black bag system and the rest via containers. No service is delivered in the rural areas due to the shortage of equipment, funds and personnel. A challenge with waste removal is that some of the roads, especially in Botleng Ext 6 and 7 are almost inaccessible during the rainy season. Due to the fast expansion of the communities, additional refuse trucks will be needed in the not too distant future.

Housing

Housing encapsulates the physical structure, which is the house, as well as the services that go with it, water and sanitation infrastructure, electricity, roads and storm water. Thus, accelerated provision and facilitation of access to housing can potentially provide a holistic

approach to alleviate the service delivery backlog. It must be taken into account that any housing programme has both a social and economic imperative. With that realisation, creation of sustainable human settlements will be achieved. The issue of the lack of low-income housing was highlighted as one the factors that lead to the increasing backlog. There are members of the community who are currently employed but cannot afford to purchase a house in the free market. Emanating from the community outreach meetings, communities have identified the need for government intervention and the forging of Public Private Partnerships (PPPs) in supporting those who cannot afford their own housing and do not qualify for the RDP and other low income housing schemes.

According to the latest figures (Stats SA 2016), just over 79.2% of households in the Victor Khanye Local Municipality live in formal dwellings/structures. If we extrapolate the figure with respect to formal housing units by the projected SDBIP1 outer year targets to 2017/18, based on available resources and funding availability and taking cognisance of the known projected increase in h/holds to approximately 24 516 units the percentage of households with access to electricity will increase to 89.8% over the next four (4) years.

4.4.2.3 Economic Development

Delmas is the primary node in the Victor Khanye municipal area. The remainder of the Municipality is largely rural in nature; however, small economic concentrations exist in a few smaller towns, namely Botleng and Eloff. The urban areas are mainly residential with supportive services such as business, social facilities etc. The economy of Victor Khanye Local Municipality is relatively diverse, the largest sector in terms of output as well as proportional contribution being Agriculture followed by community services and trade.

The Municipality is highly dependent on the neighbouring Ekurhuleni Metro for job opportunities. The land uses adjacent to the N12 Corridor should be developed as economic concentrations, capitalizing of the passers-by and the linkage it provides to regional markets. The local economy is relatively diversified with the largest sector, in terms of output as well as proportional contribution being the trade sector. The growing sector is trade sector followed by the agriculture sector and the mining sector. During recent years the total output of the agriculture sector experienced significant levels of growth while the mining and minerals sector declined. The sectors which experienced expansion in terms of output in the Victor Khanye Municipal area are (Figure 4.12):

- Agriculture;
- Manufacturing;
- Trade;
- Transport; and

- Finance.

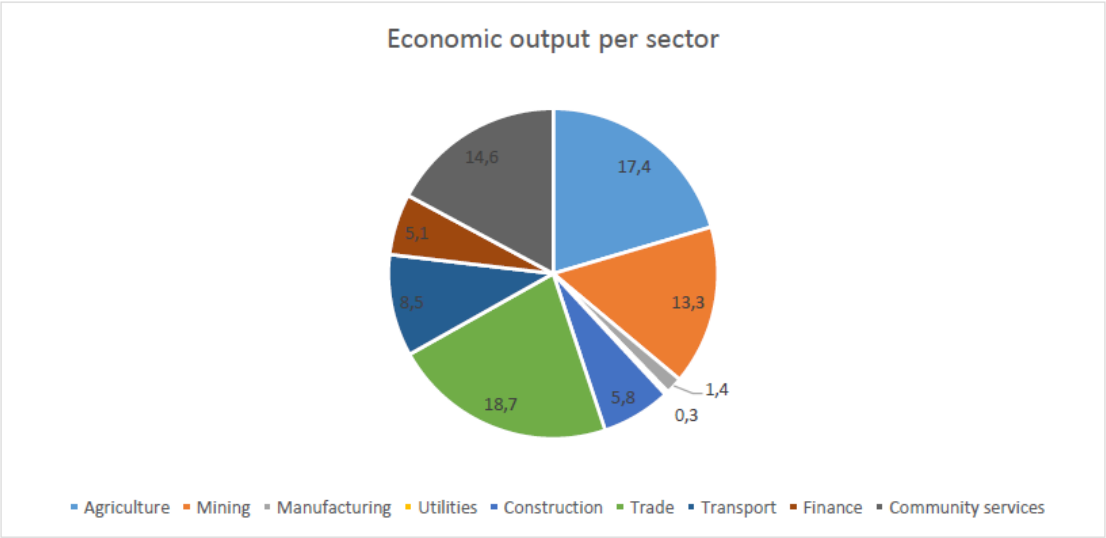


Figure 4.12 The output per sector (IDP, 2020)

With focus on mining, mining activities are concentrated mainly on coal and silica. About 3 million metric tons of coal and 2 million metric tons of silica are mined annually in the municipality. The main mining areas are around Delmas in the centre of the municipal area, and also in the far north-eastern corner of the municipal area. Importantly, there is a growing urgency to establish an equitable and realistic trade-off that maximizes the provincial benefits from mining and energy sectors while mitigating any environmental impacts. In addition, the mining, petrochemicals, steel and forestry sectors are dominated by a few global-level companies, with relatively few job opportunities being created due to their intensive capital nature.

5 ANALYSES AND CHARACTERISATION OF ACTIVITY

5.1 Site Delineation for Characterisation

Refer to Figure 1.3 for the property boundaries of the study area. No mining or mining related activities will take place outside of this area.

5.2 Water and Waste Management

The water balance for the Leeuwpan Mining Operations was updated in October 2020 by Exxaro and the process flow diagrams are illustrated in Figure 5.1 - Figure 5.4. The Water balance compiled for the Mine is attached as Annexure E to this report.

Four water balances were calculated for the Leeuwpan Coal mine and are used to provide a general insight into the overall total water demands and uses. These include an annual average monthly water balance, an average annual balance, summer condition water balance and a winter condition water balance.

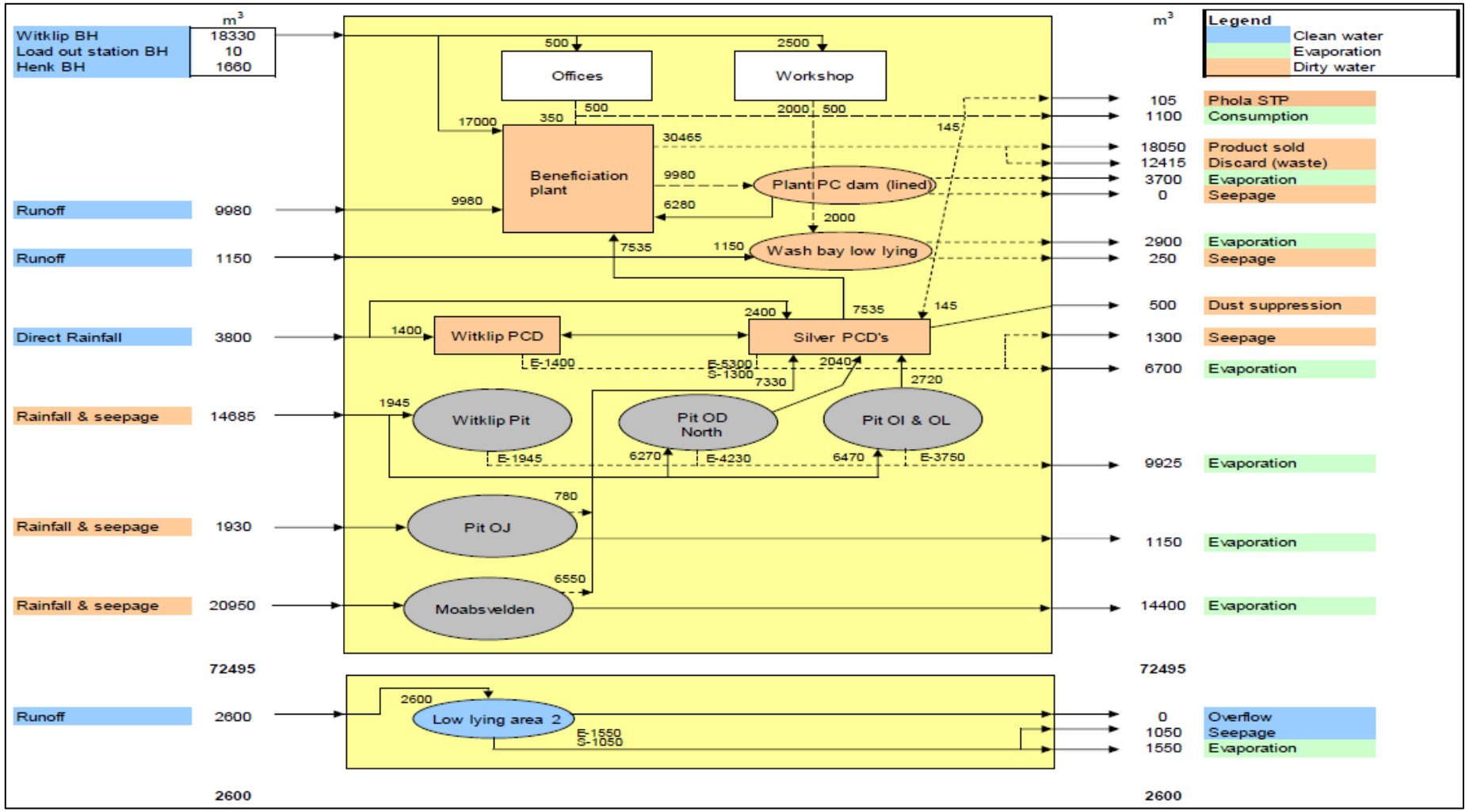


Figure 5.1 Water balance process flow diagram – Average monthly conditions

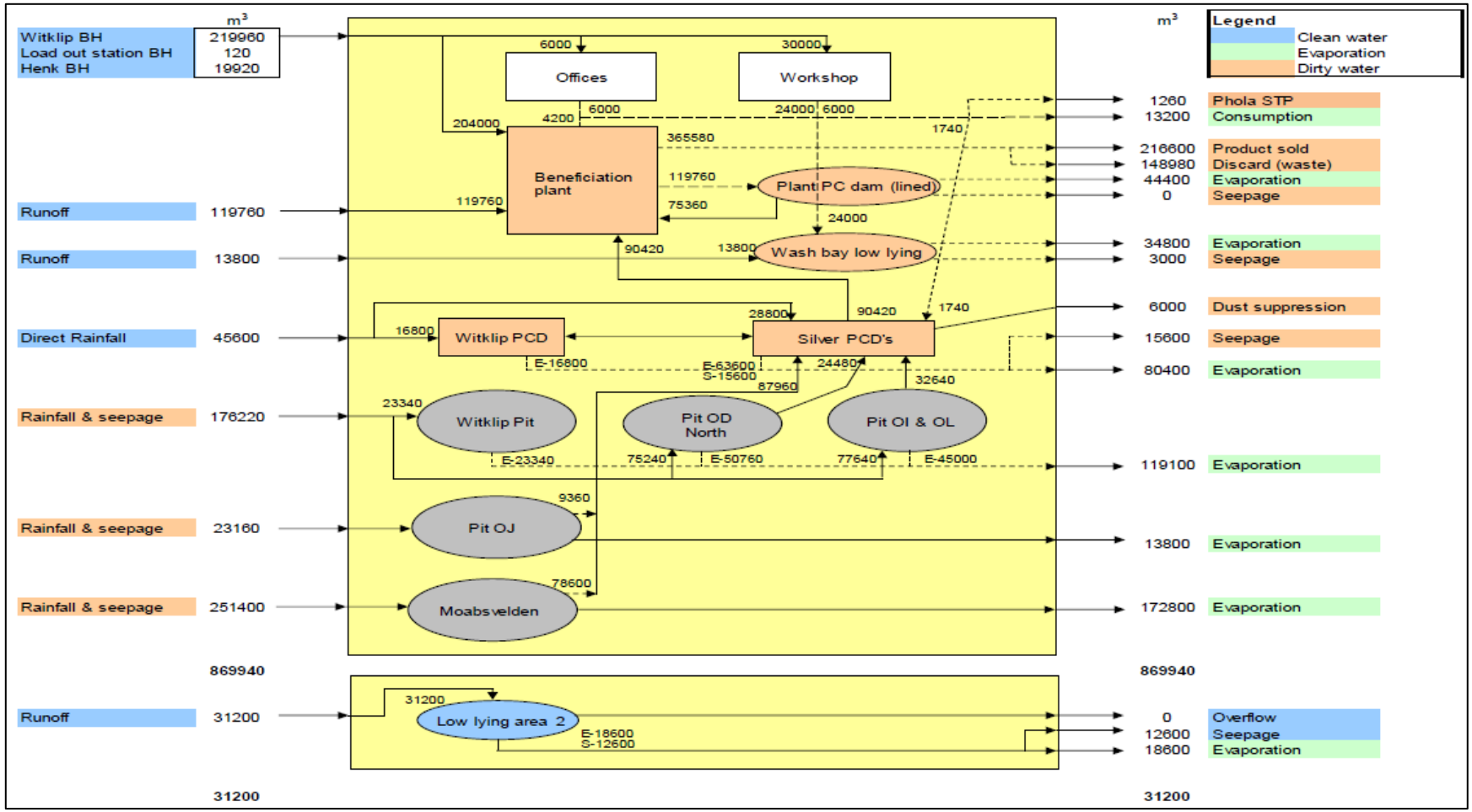


Figure 5.2 Water balance process flow diagram – Average annual conditions

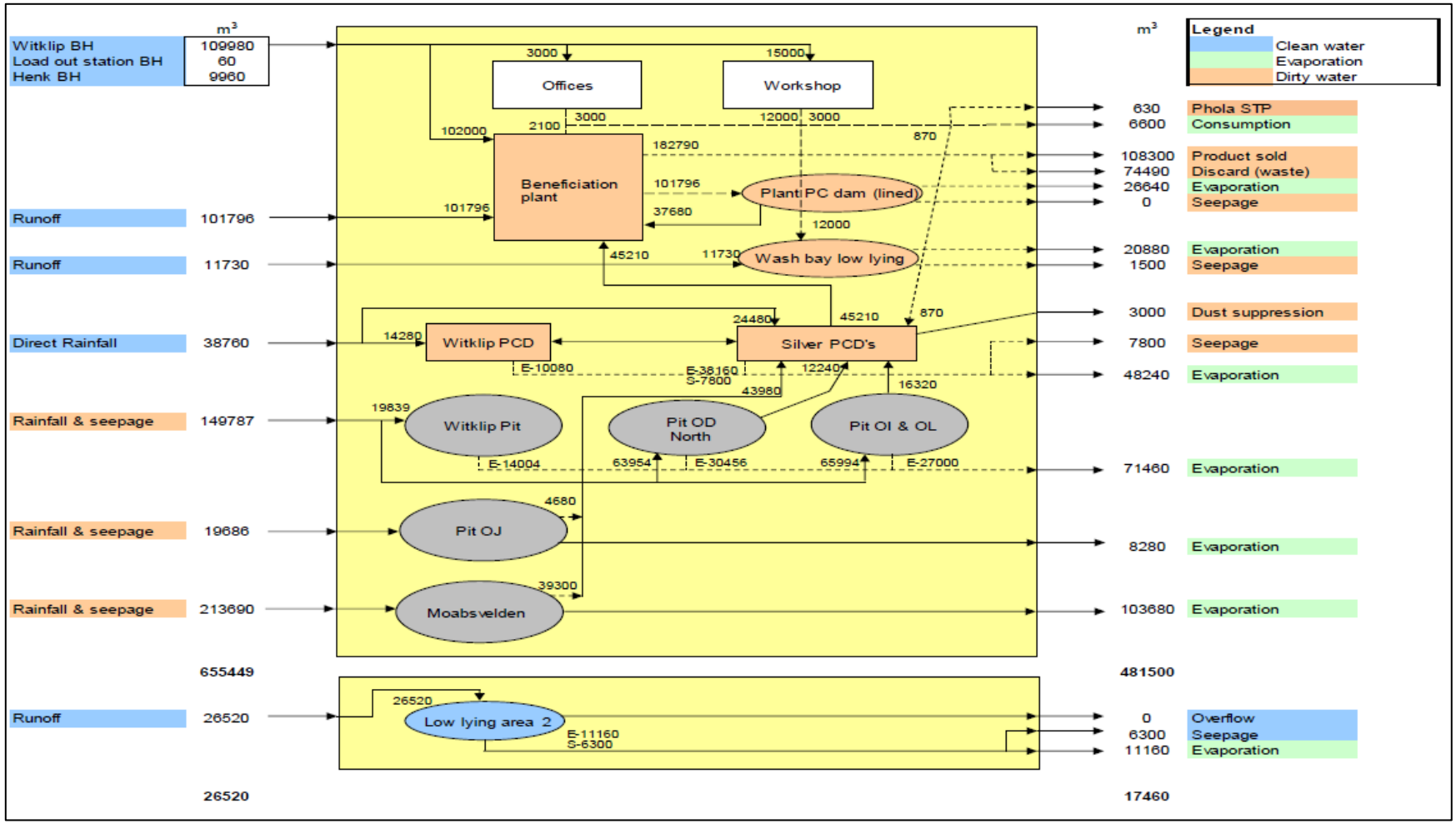


Figure 5.3 Water balance process flow diagram – Summer conditions

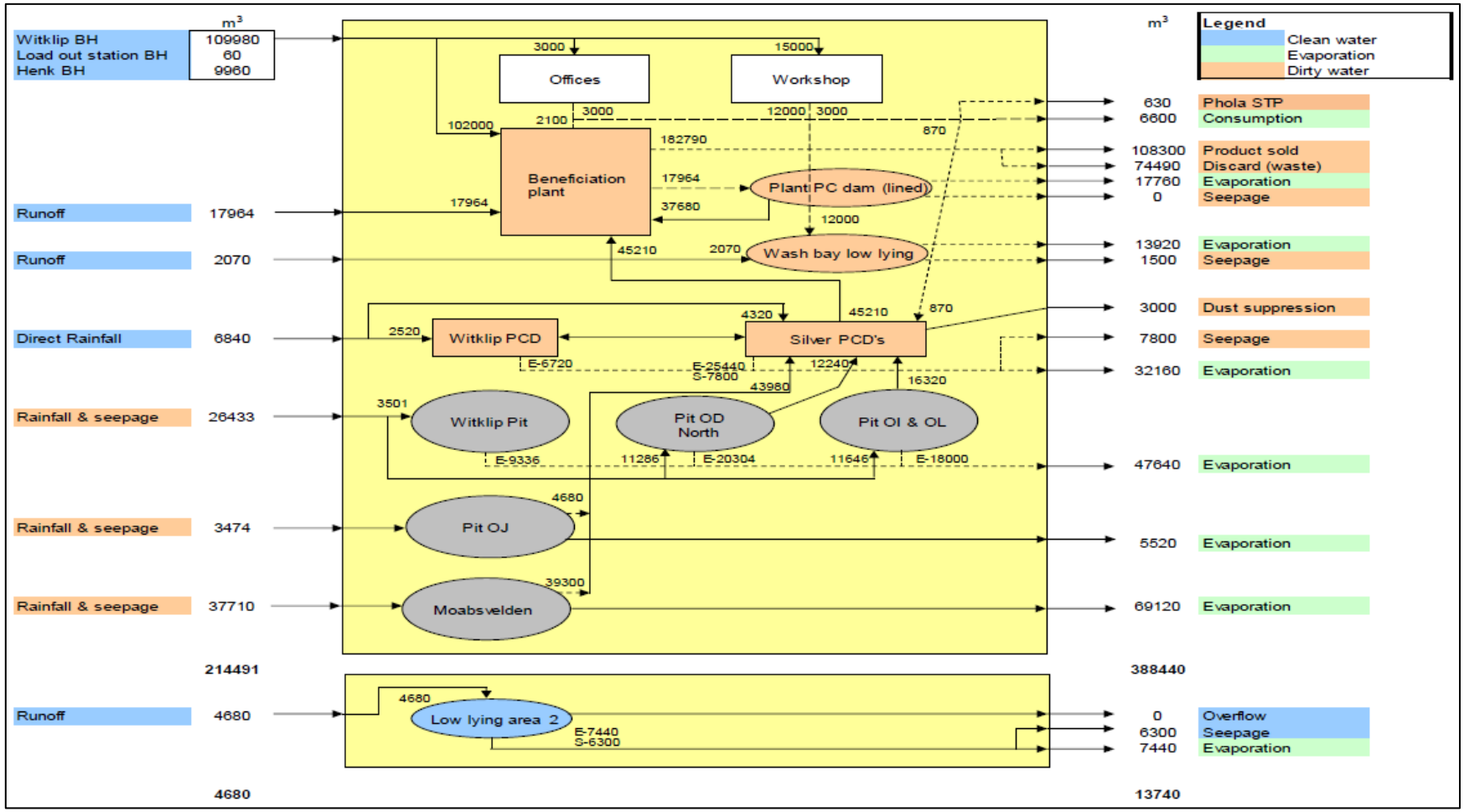


Figure 5.4 Water balance process flow diagram – Winter conditions

5.2.1 Process Water

The only process where water is used for industrial purposes is at the existing coal beneficiation plant. Process water is supplied from a closed system, which includes the plant, PCDs, mobile tanks and process dams. Water replenishment comes from the pits, but if this is insufficient, make-up water from six boreholes is also used. The WK-BH1 and WK-BH2 would contribute to this process water.

Water is used on a constant basis and is proportional to the amount of coal that is being washed per day. No significant daily fluctuations exist in the use of water on the mine. The beneficiation plant operates 24 hours a day for 313 days per year.

5.2.2 Storm Water

Government Notice No. 704, published in terms of the National Water Act (Act No. 36 of 1998) requires the following, which will be adhered to:

- All clean water systems must be designed and operated in such a manner that they are at all times capable of handling the 1:50 year flood event on top of their mean operation level without spilling;
- Any water arising from an area, which causes, has caused or is likely to cause pollution of a water resource, including polluted storm water, must be contained within a dirty water system. In order to reduce the volume of polluted water, contaminated areas should be minimised. While clean water should be diverted to natural water courses, polluted water should be re-used wherever possible, thereby reducing the use of clean water; and
- Design, construct, maintain and operate any dam or tailings facility that forms part of a dirty water system to have a minimum freeboard of 0.8m above full supply level.

5.2.2.1 Current Storm Water Management Infrastructure

Some of the existing storm water measures and infrastructure at the mine include:

- Storm water canals were built around the evaporation dams in order to prevent clean storm water from entering the dirty water area;
- For Blocks OJ and OL, the initial box cut material was used for the development of the stormwater management berms;
- Storm water cut-off trenches have been constructed around all areas where affected mine water occurs or where water might become affected. This was done to prevent clean water from mixing with affected water;
- All storm water that falls within this area has been channelled to the evaporation dams from where it will be either evaporated or re-used;

- Pollution control dams are designed to have an 800mm freeboard. The pollution control dams can therefore accommodate run-off events bigger than the 1:50 year flows;
- Storm water management facilities includes, all clean and dirty water separation structures such as berms, cut-off trenches, and silt traps;
- All water falling within a dirty water area is collected within dirty water dams for re-use;
- A series of berms and storm water diversion channels collect all the storm waters towards the Pits and respective Pollution Control Dams; and
- The pollution control dams, with the exceptions of the Raw Water Settling Dam and Emergency Overflow Dam which are unlined, are HDPE lined to prevent leakages and ingress into ground water and possibly contaminating the surface and ground water.

5.2.3 Groundwater

The water from the WK-BH1 is pumped to the Silver Tank where it is distributed to the plant as well as the mining area, mining offices and the engineering workshops which use the water as potable water. The WK-BH2 is only intended to be used for back-up purposes and will only be pumped if WK-BH1 cannot be abstracted.

In addition to this application, groundwater is also abstracted from the existing pits and is authorised as part of the existing IWULs issued. The water is abstracted for the safe continuation of mining activities and used as process water in the processing of the ore mined.

The IWUL issued to Leeuwpan also licensed the abstraction of groundwater from other boreholes (excluding WK-BH1 and WK-BH2) located at the mine. The borehole water is used for process water at the mine when there is insufficient water from the pits.

5.2.4 Waste

There are several waste sources that have been identified as part of the mining activities at Leeuwpan. These waste sources include:

- Mine Residue Deposit (MRD), which includes:
    - carbon-carrying shales;
    - plant residue; and
    - fine coal recovered from the slimes dams.
- Polluted mine water, which includes the various pollution control dams;
- Hazardous and Hydrocarbon waste such as oil, diesel & grease; and
- General waste which is limited to domestic and commercial waste.

Refer to Section 3.6 for details pertaining to the management and disposal of the various waste streams generated at Leeuwpan.

5.3 Operational Management

5.3.1 Organisational Structure

Refer to Figure 2.4 above in Section 2.7 for the organisation structure of Leeuwpan Mine.

5.3.2 Resources and Competence

Leeuwpan Coal comprises of mining-, process-, technical-, administration- and the surface infrastructure related operations that are undertaken during all phases of the operation. The mine's Environmental Management System (EMS) is ISO 14001:2004 and OHSAS 18001:2007 based and describes the principles of implementing policies and environmental programmes.

The management, operational and monitoring procedures and codes of practices have been compiled to manage the significant aspects and impacts of the activities and products of Leeuwpan Coal. The system also involves local Authorities, contractors working on-site, government agencies and Interested and Affected Parties (I&APs). In addition, Figure 2.4 indicates the competence at Leeuwpan.

Leeuwpan Coal is committed to the implementation of the Exxaro Resources Safety, Health and Environmental (SHE) Management Policy. Exxaro Resources actively care for the health and safety of people, the environment and resources by ensuring sustainable Safety, Health and Environmental (SHE) conditions at all of Exxaro's activities.

Exxaro Resources is committed to:

- Consulting with employees and representatives and other stakeholders in appropriate forums to develop, communicate and review responsible and innovative policies, programmes and guidelines that proved safeguards for the community, employees, contractors and the environment, while providing flexibility to meet the needs of the Exxaro businesses;
- Achieving high standards of environmental care and providing a safe and healthy workplace for employees, contractors and other relevant persons;
- Ensuring a proper organisational structure and resources to manage safety, health and environmental matters including sustainable development and legal compliance;
- Implementing internationally accepted standards for safety, occupational health and Environmental Management Systems (EMS);

- Complying with all applicable SHE legislation and relevant international obligations as a minimum requirement and implementing company standards, programmes and processes to achieve greater protection against risks;
- Maintaining continuous hazard and aspect identification and risk assessment regarding safety, health and environmental impact;
- Establishing competence and awareness regarding relevant safety, health and environmental matters of employees and contractors through effective training, mentoring and communication;
- Conserving natural resources and reducing the environmental burden of waste generation, disposal and emissions to the air, water and land through strategies focusing on reducing, re-using, recycling and safe deposit / disposal of waste;
- Establish objectives / targets and continuously improve operations regarding safety, health and environmental performance and management systems;
- Ensuring that all employees report potential safety, health and environmental hazards and impacts, and be included in the planning and implementing of solutions;
- Ensuring that all incidents leading to an environmental impact, injury, occupational disease, damage to property or process losses are reported and analysed thoroughly in order to determine all contributing factors to promptly implement corrective and preventive action;
- Establishing and maintaining appropriate controls, including periodic audits and reviews, to ensure that this policy is being implemented and updated; and
- Maintaining a high level of emergency preparedness and response to manage any potential emergency.

5.3.3 Education and Training

The awareness and training information is contained in the Training Awareness and Competence Procedure (No. SP LP-SHE 006, dated September 2015). This procedure provides a framework to ensure all staff, contractors and consultants at Leeuwpan Coal, whose work may create a significant risk on the Integrated Management Systems (IMS), receives appropriate training. It provides guidelines for increasing over-all employee awareness on SHE issues in general, the significant environmental aspects, SHE hazards at Leeuwpan Coal and the SHE policy.

5.3.4 Internal and External Communication

Leeuwpan Coal has implemented the Communication and Consultation Procedure, dated December 2004, to outline the procedure followed by the mine to ensure effective internal and external communication. Internal or external complaints are handled according to SPI LP-SHE.001. The information from this procedure is summarised below.

Communication at Leeuwpan Coal is conducted according to the following (Figure 5.5):

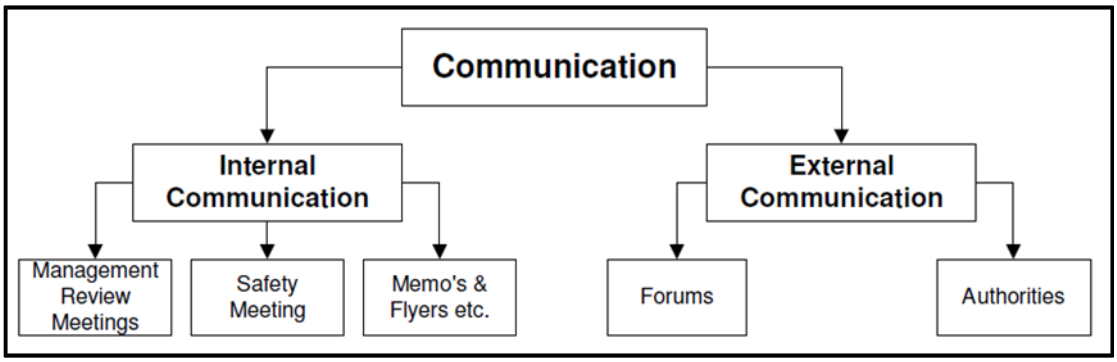


Figure 5.5 Internal Communication

The Mine Manager of Leeuwpan Coal must ensure that all relevant Safety, Health and Environment (SHE) information is passed on to the line managers for dissemination to employees at all levels regarding the effectiveness of the SHE system. The SHE Manager ensures that consultation & communication on SHE matters is conducted during the scheduled SHE Forum meetings. Communication is also conducted at the scheduled SHE management review meetings.

Employees are informed and involved with relevant risk assessments and where changes to work places occur. SHE Representatives have been appointed and employees are informed as to whom it is. The signature on the risk assessment documentation is proof of the consultation process regarding that specific risk.

Communication on internal SHE issues takes place when necessary through personnel information sessions, newsletters, production meetings, SHE Forum meetings, etc.

Key stakeholders have been identified for Leeuwpan Coal. These include surrounding industries, other mines in the area, the Delmas Municipality, Eskom as well as the surrounding landowners. The key stakeholder list is updated for every new project taking place at Leeuwpan Coal to ensure that public involvement in the decision making process.

Relevant Authorities for Leeuwpan Coal have also been identified. These include the following Departments, which are consulted at all stages of project planning to ensure that correct processes are followed at all times:

- Department of Human Settlement, Water and Sanitation (DHSWS);
- Department of Mineral Resources and Energy (DMRE); and

- Department of Economic Development, Environment and Tourism (DEDET).

5.3.5 Awareness Raising

The Training, Awareness and Competence Procedure (No. SP LP-SHE 006, dated September 2005) ensures that all staff is made aware of their individual roles and responsibilities in achieving conformance with the SHE policy, procedures and the requirements of the IMS, including emergency preparedness and response. This procedure describes:

- The assessment of the competence of all personnel in terms of the IMS;
- The provision of training and other actions to satisfy the identified needs;
- The evaluation of the effectiveness of the actions taken;
- The assurance that those personnel are aware of the relevance and importance of their activities and how they contribute to the achievement of the SHE objectives; and
- The maintenance of education, training, skills and experience records.

5.4 Monitoring and Control

The key to the success of environmental management lies in the effective implementation of the proposed mitigation and management measures. Monitoring provides qualitative and quantitative information pertaining to the possible impacts of the development on the environment and enables the measurement of the effectiveness of environmental management measures.

This monitoring programme allows the mine to monitor its compliance in terms of the NWA for its entire mining operations. Refer to Table 5.1 for a summary of all monitoring components for Leeuwpan Coal.

Table 5.1 Summary of Components monitoring for Leeuwpan

Aspect	Component	Frequency of data collection
Surface water	Surface water quality	Monthly
	Water consumption levels	Daily
Groundwater	Groundwater quality	Quarterly
Wetland Monitoring	Assess current status of affected wetlands	Biannually
Biomonitoring	Biological integrity of aquatic habitats	Biannually

The objective of the water monitoring programme currently in place at Leeuwpan Coal is to assess and quantify the impacts of the existing Leeuwpan on the aquatic ecosystems and receiving waters.

Sampling is performed according to recognised legal procedures (minimum requirements for water monitoring at waste management facilities, Department of Water Affairs and Forestry (DWAF), 1998) and follows approved laboratory analysis techniques.

The NWA sets out a framework for the management of water resources in South Africa. This framework provides for the establishment of water management institutions, made up of role-players in each catchment. It is therefore of utmost importance that the requirements of down-stream users be determined pro-actively.

5.4.1 Surface Water Monitoring

Monthly monitoring of the various surface water monitoring points is conducted, as well as from the Bronkhorstspruit localities, which are up and downstream from potential impact points that may originate from Leeuwpan. Results generated at these localities are used to characterise and identify potential pollution sources on the mine, and for early detection of acid mine water formation. Samples are also taken on a monthly basis from each of the monitoring localities for drinking water. A sample is taken in a sterile container and this water is analysed for bacterial species richness and diversity. Surface water monitoring at the Leeuwpan Mine is currently conducted by Environmental Assurance (Envass). The latest water quality report (October 2020) for the Mine is attached as Annexure C to this report.

The main objectives of the surface water monitoring:

- To assess, on a monthly basis, the quality of the surface water resources in and around the Leeuwpan study area in accordance with the mine's approved IWUL (number 04/B21A/ABCGIJ/429) and its amendments;
- To make use of the data for both human and environmental health and impact assessments;
- To compare results to previous survey results with the aim of detecting environmental trends in the surface water quality; and
- To identify potential impacts of the mining operations on the receiving water resources and provide suitable mitigation measures for adaptive management.

The surface water monitoring points and their respective geographical information is provided in Table 5.2. The geographical positions are illustrated in Figure 5.6 - Figure 5.9.

Table 5.2 Leeuwpan Surface Water Sampling Points

Locality	Description	Coordinates	
		Latitude	Longitude
Drinking water and final sewerage effluent			
LDWST	Drinking Water Supply Tank	S-26.18005	E28.73602
LLBDW	Loadout Bay Offices Drinking Water	S-26.16590	E28.72990
LWDL	Drinking water at Laboratory	S-26.17128	E28.72797
Piet Schutte	Drinking Water on Piet Schuttes Farm	S-26.14150	E28.80170
Final effluent samples (Waste water)			
LWP SP P	Final Effluent from Septic Tanks at Plant	S-26.1716	E28.7302
LWP SP W	Final Effluent at Sewage Plant behind workshop	S-26.1812	E28.7396
Surface water and receiving environment			
LSW07	Bronkhorstspruit, upstream	S-26.18860	E28.77635
LSW05	Bronkhorstspruit, downstream	S-26.13750	E28.75700
LSW03	Bronkhorstspruit at Delmas Silica	S-26.16279	E28.76881
LSW08	Bronkhorstspruit upstream of Block OI	S-26.23022	E28.76264
LSW06	Weltevreden Spruit at Farm - Upstream	S-26.1439	E28.7955
LSW12	Wetland in River Diversion 2, Between RD2 And LSW05	S-26.13610	E28.76410
LSW13	Stormwater flowing into River diversion 2	S-26.14380	E28.77560
RD1	River Diversion 1	S-26.14930	E28.76450
WP01	Bronkhorstspruit, upstream	S-26.17799	E28.70221
WP02	Bronkhorstspruit, downstream	S-26.15510	E28.70260
Mine water-Process water			
LSW09	Pollution Control Dam	S-26.16601	E28.72541
KRO1A	Kenbar Return Water Dam	S-26.18087	E28.72995
KRO3	Workshop oil separator sump	S-26.18197	E28.73827
KRO4	Marsh area next to workshop road	S-26.18672	E28.73381
WP04	New Witklip Return Water Dam	S-26.17234	E28.70640
0G Pit	0G Pit Water (backfilled pit)	S-26.17119	E28.73397
OH Pit	OH Pit Water	S26.16698	E28.75338
OJ Pit	OJ Pit Water	5-26.16854	E28.74505
OWM Pit	OWM Pit Water	S-26.14440	E28.74875
ODN Pit	OD Pit North	S-26.17122	E28.72381
OM Pit	OM Pit Water	S-26.17278	E28.74875
WLV Pit	Weltevreden Pit	S-26.12888	E28.76050
Additional sampling points (not specified in the WUL)			
Kenbar Rehab	Backfilled former Kenbar Pit	S26.1735	E28.7333
OJ-O	Field Barrels for experimental work		
OJ-S4-DISC			
OH-WEATH			
OL-OVB(2A+2B)			

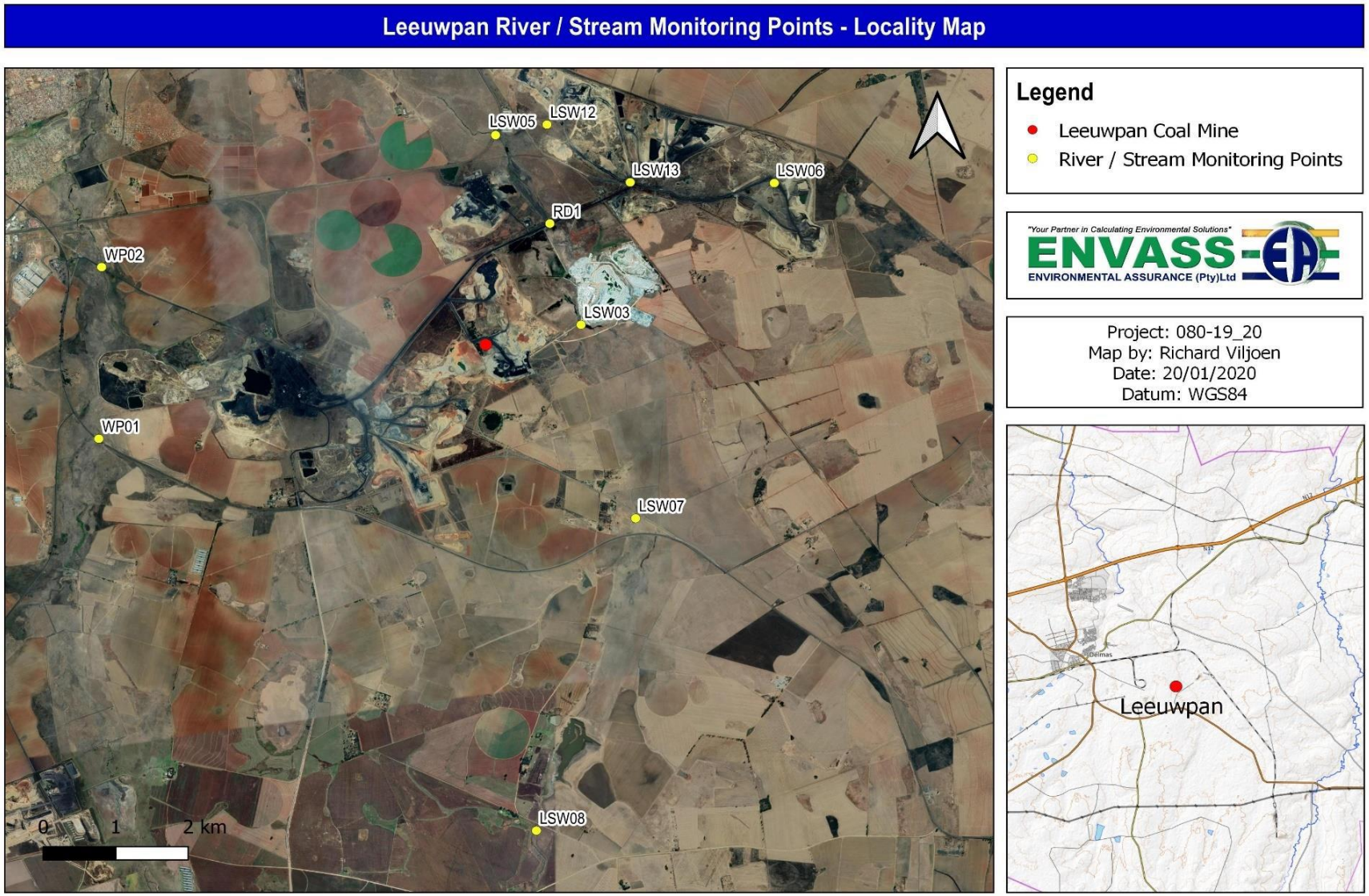


Figure 5.6 Receiving Environment Water Sampling Locality Map

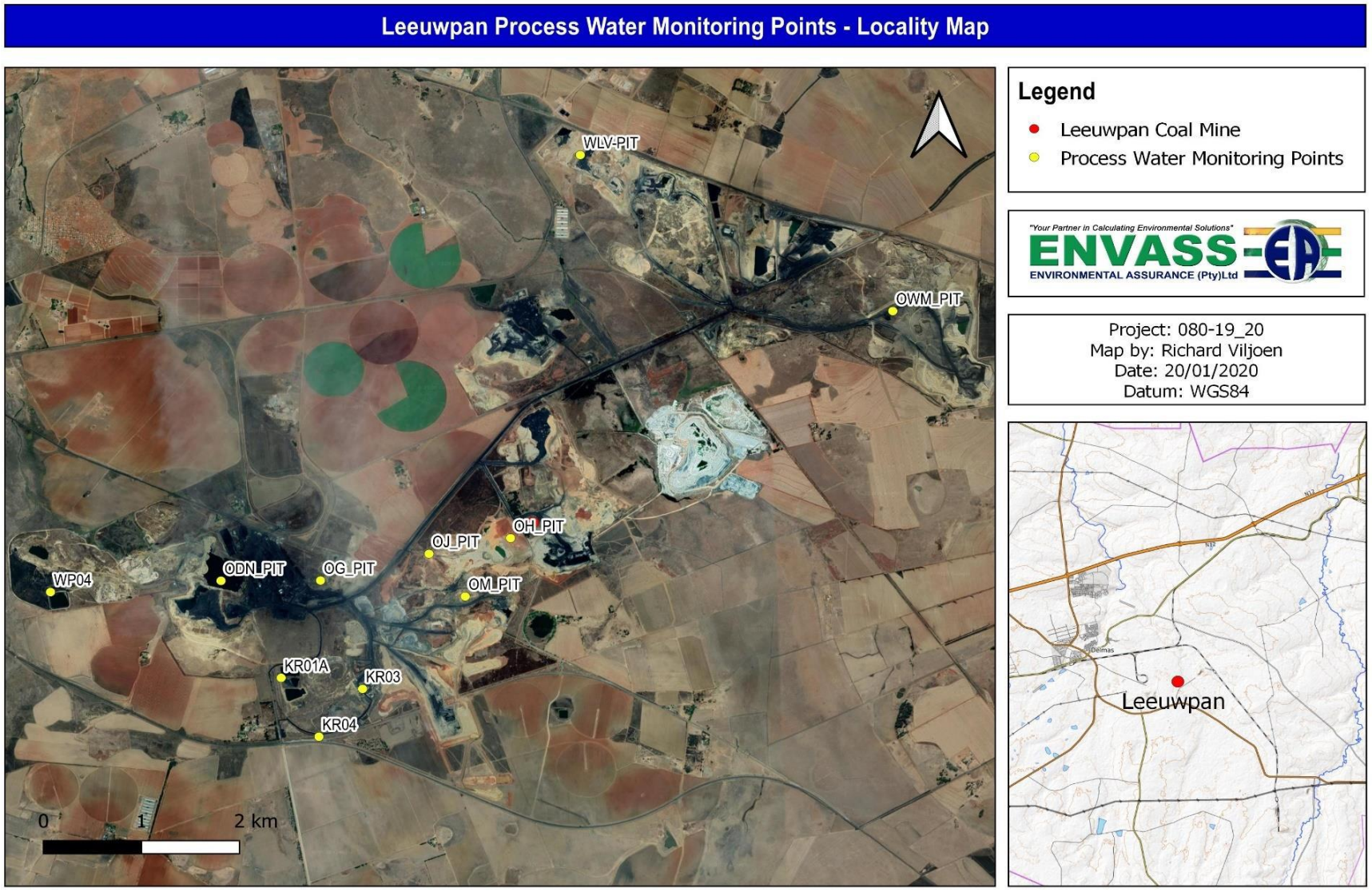


Figure 5.7 Process Water Sampling Locality Map

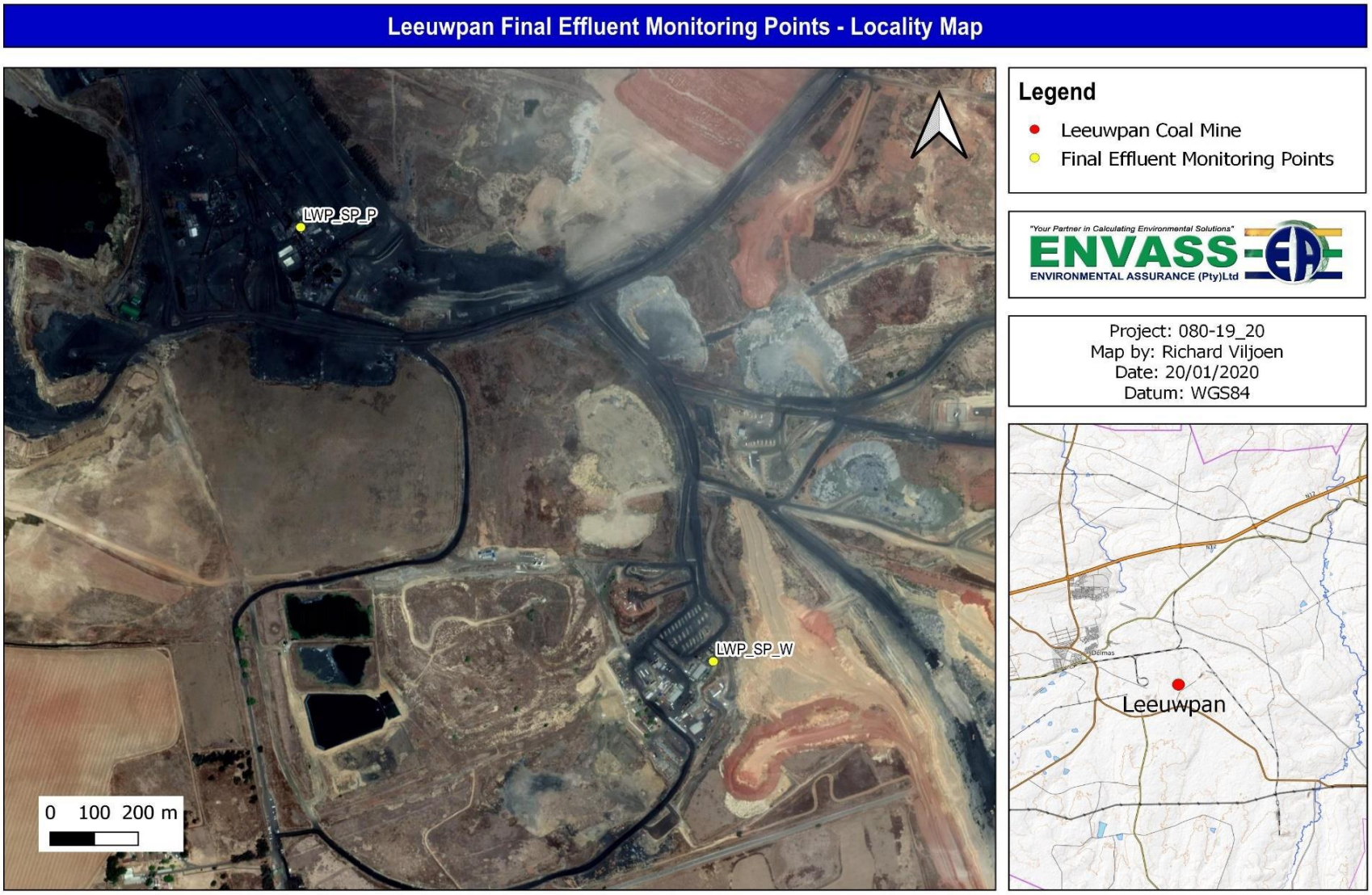


Figure 5.8 Effluent Water Sampling Locality Map

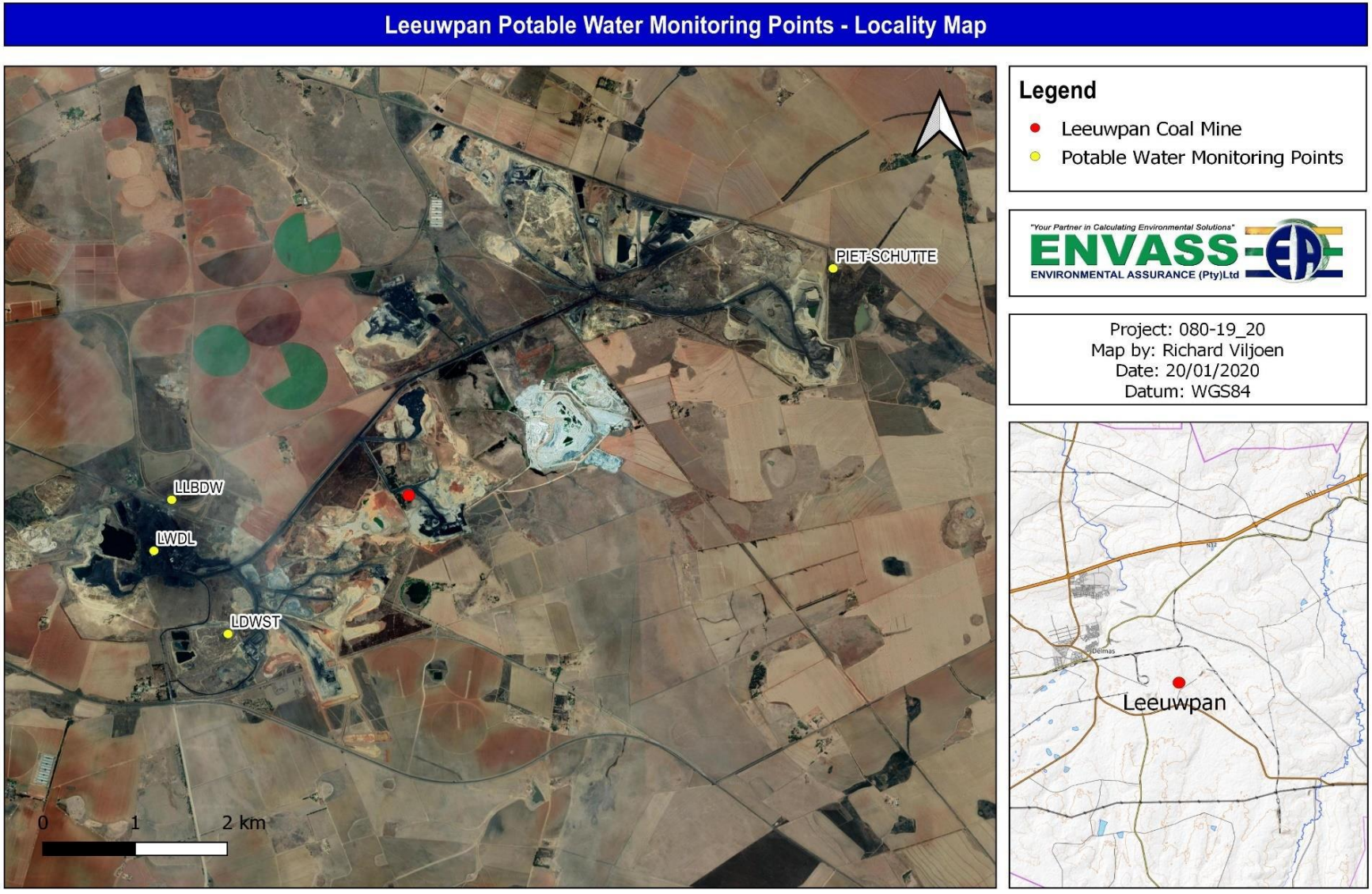


Figure 5.9 Potable Water Sampling Locality Map

5.4.1.1 Parameters Tested for

The parameters that are tested for are provided in Table 5.3.

Table 5.3 Water quality parameters for Leeuwpan Coal Mine

General Analysis Package	Potable Water	Surface Water	Treated Sewage
pH	X	X	
Electrical conductivity	X	X	
Total Dissolved Solids	X	X	
Suspended Solids			X
Total Hardness	X	X	
Total Alkalinity	X	X	
Calcium	X	X	
Magnesium	X	X	
Sodium	X	X	
Potassium	X	X	
Fluoride	X	X	
Chloride	X	X	
Sulphate	X	X	
Iron	X	X	
Manganese	X	X	
Aluminium	X	X	
Boron		X	
Hexavalent Chromium		X	
Ammonia	X	X	X
Nitrate	X	X	X
Total inorganic nitrogen (TIN)		X	
Ortho-Phosphate	X	X	X
Total Phosphate		X	X
Chemical oxygen demand (total)			X
Turbidity (in-situ)	X	X	
DO (in-situ)	X	X	
Dissolved Organic Carbon		X	
Sodium adsorption ratio (SAR)	X		
Oil & grease		X	
Chlorophyll-a		X	
Escherichia coli (E.coli)	X	X	X
Faecal Coliforms			X
Heterotrophic plate count	X		

General Analysis Package	Potable Water	Surface Water	Treated Sewage
Al, As, B, Ba, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Se, Si, Sr, Ti, V, Zn, Hg, La, Lu, Sb, Sn, Th and Tl	X		

5.4.2 Groundwater Monitoring

5.4.2.1 WK-BH1

It is recommended that the water levels in the borehole WK-BH1 be electronically monitored with the use of a downhole water level monitoring device (level logger). Table 5.4 summarises the borehole information and monitoring frequency. The data obtained from this monitoring should be used to evaluate the recommended abstraction volumes. A flow meter should be fitted on the borehole and the volumes should be adjusted if a decline in water level is observed in the monitoring data. The locations of the boreholes mentioned in Table 5.4 are shown in Figure 5.10.

Table 5.4 Water Level Monitoring Plan for WK-BH1

Borehole ID	Latitude	Longitude	Sampling Frequency	Method
[-]	[DD]	[DD]	[-]	[-]
WK-BH1	-26.17330	28.71013	Hourly	Electronic Water Level Monitor
WWNMB16	-26.178517	28.711015	Daily	Electronic Water Level Monitor
WWNO1	-26.174380	28.717220	Daily	Electronic Water Level Monitor
To be Verified	-	-	Hourly	Electronic Water Level Monitor

Groundwater sampling of all water sources used are also recommended on a bi- annual basis and according to the groundwater modelling report (GCS, 2019). The water quality should be analysed by a hydrogeologist and be compared to historical groundwater quality standards in order to ensure that no pollution of the aquifer is taking place.

Borehole ID	Water used for	Sampling Frequency	Analysis
WK-BH1	Mining (production)	Bi-annual	As per Table 4.10

5.4.2.2 Overall Groundwater Monitoring of the Mine

Groundwater monitoring is performed at thirty-six (36) borehole monitoring points (Table 5.5). Monitoring is performed on a quarterly basis (March, June, September and December) and is tested for the variables as listed in Table 2 (Refer to the WUL for groundwater requirements). The monthly sampling register of the surface water localities indicated in Table 5.5 have been summarised in Appendix A of Annexure H. Refer to Figure 5.10 for the localities of the monitoring boreholes.

Table 5.5 Groundwater Monitoring (Envass, 2020)

Groundwater Monitoring			
Sample ID	**Description**	**Latitude**	**Longitude**
EMPR02/E2	West of ODN pit	S 26° 9.7314'	E 28°43.0668'
KENMB1	Fuel Dispensary	S 26° 10.9176'	E 28°44.2698'
KENMB2-D	Silver Dam 2	S 26°10.7604'	E 28°43.8452'
KENMB2-S	Silver Dam 1	S 26° 10.761'	E 28°43.827'
KENMB3-D	PLANT/Stockpile 1	S 26°10.1738'	E 28°44.2325'
KENMB3-S	PLANT/Stockpile 2	S 26°10.2819'	E 28°43.8080'
LEEMB18-D	Plant Conveyor 2	S 26°10.0902'	E 28°43.6521'
LW07	North of Witklip	S 26°09.9706'	E 28°42.6314'
LW08	South West of Kenbar	S 26O11.0940'	E 28°43.6227'
LW10	South of Delmas Silica (borehole does not exist)	S 26°9.8760'	E 28°45.90'
LWG01	South of Kenbar	S 26°10.7796'	E 28°43.7256'
LWG02	South East of Kenbar	S 26°10.7461'	E 28°44.2200'
LWG04	Moabsvelden Groundwater	S 26°10.4568'	E 28° 45.3546'
MOAMB10	Block OI New Mine Area 1	S 26°09.9010'	E 28°45.9177'
MOAMB4	Block OH	S 26°10.0472'	E 28°44.6280'
MOAMB7	Block OJ / Stuart Coal Upstream	S 26°09.2321'	E 28°45.3272'
MOAMB9	Block OI New Mine Area2	S 26°10.5353'	E 28°46.0158'
RIE10	Rietkuil Monitoring Borehole	S 26°12.0996'	E 28°45.8058'
RIE10B	Rietkuil Monitoring Borehole	S 26°12.0783'	E 28°45.8202'
RIE4	Rietkuil Monitoring Borehole	S 26°11.3292'	E 28°46.104'
RKL01	Rietkuil Monitoring Borehole	S 26°11.0684'	E 28°44.6443'
RKL03	Rietkuil Monitoring Borehole	S 26°11.355'	E 28°46.248'
RKL04	De Denne Monitoring Borehole upstream of	S 26°11.8884'	E 28°44.5146'
RKL02	Rietkuil Monitoring Borehole	S 26°10.9936'	E 28°45.9942'
WELMB13-D	Moabsvelden 1	S 26°08.6306'	E 28°46.7083'
WELMB13-S	Moabsvelden 2	S 26°08.6364'	E 28°46.6961'
WITMB14	Block OA	S 26°10.0137'	E 28°42.3247'
WOLMB15-D	ODN/PCD1	S 26°09.9538'	E 28°43.4233'
WOLMB15-S	ODN/PCD 2	S 26°09.9548'	E 28°43.4306'
WTN02-D	Weltevreden Monitoring Borehole - Deep	S 26°8.7840'	E 28°46.1604'
WTN02S	Weltevreden Monitoring Borehole - Shallow	S 26°8.7840'	E 28°46.1598'
WTN01-D	Weltevreden Monitoring Borehole	S 26°8.0976'	E 28°45.942'
WTN01-S	Weltevreden Monitoring Borehole - Shallow	S 26° 8.0976'	E 28° 45.942'
WWNMB16	Block UB	S 26°10.7110'	E 28°42.6609'
WWN01	Wolvenfontein Monitoring Borehole	S 26° 10.4628'	E 28° 43.0332'
WWN02D	Wolvenfontein Monitoring Borehole - deep	S 26°10.4475'	E 28°43.0969'

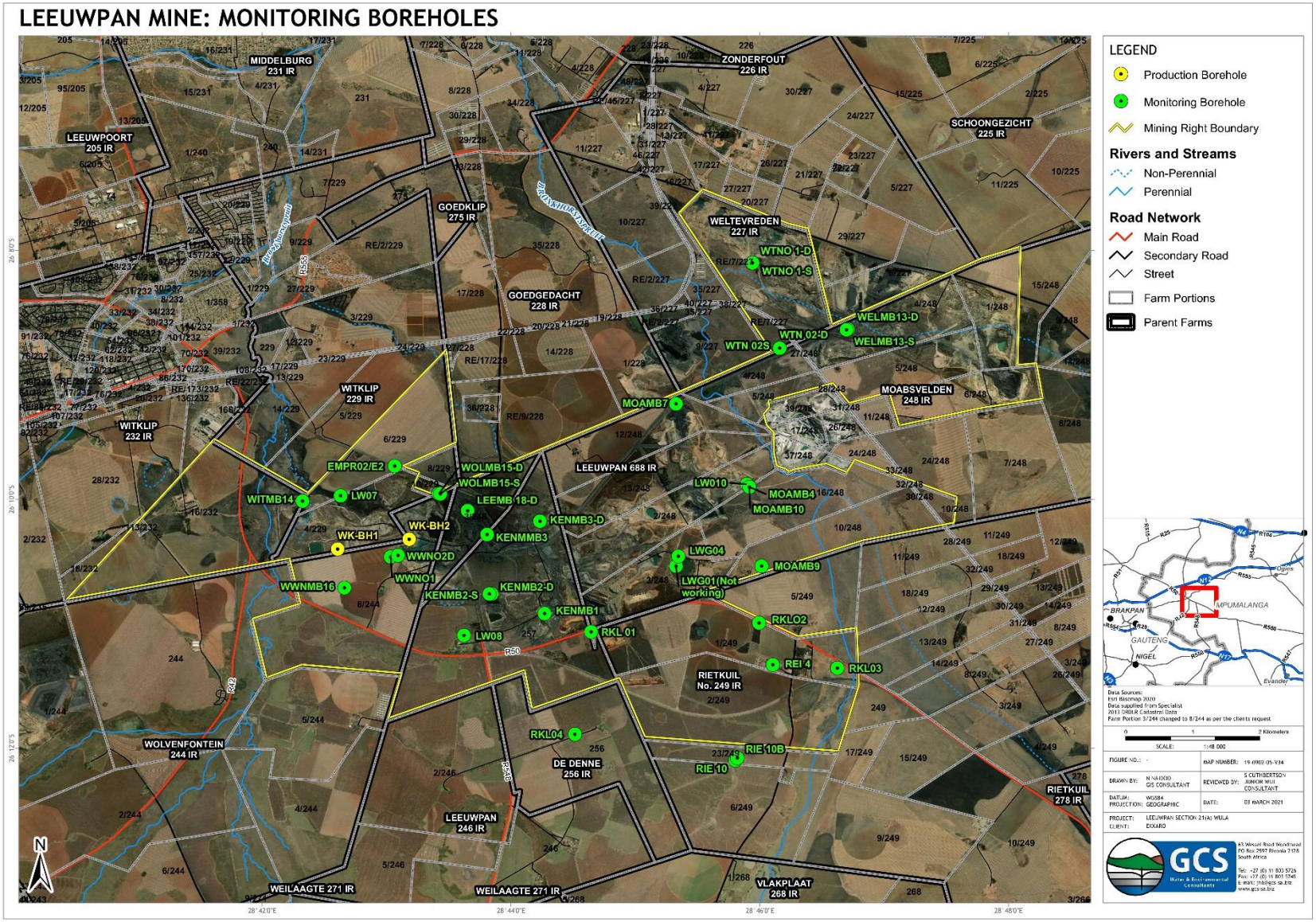


Figure 5.10 Groundwater Monitoring Boreholes

5.4.3 Biomonitoring

Biomonitoring at the Leeuwpan Mine is currently conducted by Environmental Assurance (Envass). The latest biomonitoring report (September 2020) for the Mine is attached as Annexure D to this report.

Four (4) biomonitoring predetermined sites were selected on representative aquatic systems up and downstream of the study site (Figure 5.11). These sample points were presumably chosen as a result of:

- Their vicinity to the study area; and
- Their ability to represent the various biotopes/habitats that are required for the SASS5 and IHAS methodologies.

Bronkhorstspruit SQR no. B20A- 1298:

- LP-WEL-DS: Downstream of the Leeuwpan Colliery on a Weltevreden Tributary. SASS5, IHAS, Diatom analysis and toxicity testing were conducted at this site; and
- LP-RK-US: Upstream of the Leeuwpan Colliery on a Rietkuil Tributary. This site indicated stagnant conditions during the 2020 dry season field survey, the Diatom analysis and toxicity testing were conducted at this site at a small pool.

SQR no. B20A- 1308:

- LP-BS-DS: Downstream of the Leeuwpan Colliery on the Bronkhorstspruit River. SASS5, IHAS, Diatom analysis and toxicity testing were conducted at this site; and
- LP-BS-US: Upstream of the Leeuwpan Colliery on the Bronkhorstspruit River. SASS5, IHAS, Diatom analysis and toxicity testing were conducted at this site.

Quarterly DEEEP Toxicity Testing Sites:

- KR01A: Kenbar Return Water Dam (RWD), which replaces the mined-out D-DS site;
- D-DS (LSW13): Divergent channel 3 on-site, which flows into a Weltevreden Tributary and then into the downstream Bronkhorstspruit River; and
- LSW09: Pollution Control Dam (PCD) on-site.

The localities of the biomonitoring sites are illustrated in Figure 5.11.

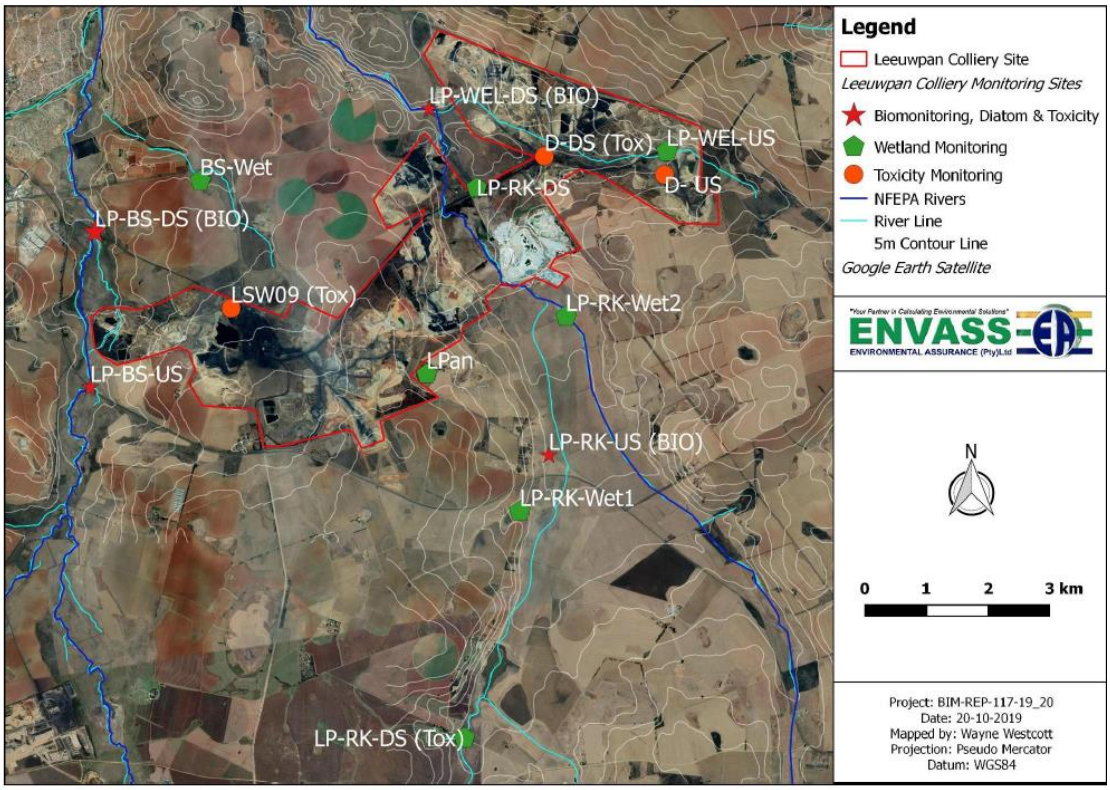


Figure 5.11 Biomonitoring sites (dry season)

5.4.3.1 Overall Assessment

It is evident that the aquatic systems in the vicinity of the existing licensed Leeuwpan Colliery have been moderately disturbed by the current and historical land-uses, specifically agriculture, within the catchment area. Based on the water quality, IHAS and SASS5 analysis this impact can be mitigated by following protocol throughout the production process onsite, adhering to the limits stipulated within the WUL (Ref no. 04/B20A/CIJ/4032) and implementing the recommendation stipulated below. The attributes that influenced this conclusion included the following:

- Slight decrease in overall water quality from upstream sites LP-BS-US to LP-BS-DS and from LP-RK-US to LP-WEL-DS. This trend was mirrored in the diatom assessment, which highlighted more eutrophic and higher pollution levels at the LP-BS-DS site than the upstream LP-BS-US site. Adversely, more organic pollution was recorded at the upstream LP-RK-US site than at the corresponding downstream LP-WEL-DS site, but both samples indicated eutrophic conditions. The upstream site (LP-BS-US) was determined to pose no acute or short-chronic environmental hazard, however the downstream site (LP-BS-DS) was determined to be of a slight environmental toxicity hazard presented by a Direct Estimate of Ecological Effect Potential (DEEEP) Class II. Subsurface seepage from a historic farm dam situated within the Leeuwpan Colliery at 26° 10’ 00.22” S, 28° 42’ 41.98” E was observed to be flowing into the downstream

tributary of the Bronkhorstspruit River above site LP-BS-DS. There may therefore be an influence from this farm dam on the change in toxicity levels evident at LP-BS-DS. Surrounding land-uses were also considered, however as a higher flow volume was entering the system from farm dam than the agricultural croplands and stormwater runoff from the adjacent tar road, it was determined to have a higher influence on this conclusion.

- The previously elevated pH has decreased unto overall acceptable levels, likely the result of dilution due to increased rainfall in the area prior to the assessment. This was mirrored by both sites having improved and only LP-WEL-DS being determined to fall within Class II (Slight environmental toxicity hazard) toxicity, LP-WEL-DS recording Some Degree of Acute/Short- chronic Toxic Hazard (S.D.O.T.H) at one (1) trophic level.
- The diatom analysis recorded eutrophic conditions at LP-WEL-DS and the conclusion was that the habitat decreased and impacted water quality was evident. The diatom analysis on the downstream point LP-BS-DS also indicated slightly impacted water quality, however this impact was largely present in the upstream environment at LP-BS-US as well. However, since the on-site sampled revealed no acute toxicity it cannot be conclusively stated that the pollution is attributed to the site. These results revealed that surrounding activities in the upstream environment had a definitive impact and only a slight decrease was observed at the downstream point.
- The overall increase in aquatic macroinvertebrate health at the downstream biomonitoring sites was presumably due to the dilution of water attributed to the elevated availability of water at the monitoring points and the overall increased water quality measured and therewith the slightly improved habitat.

5.4.3.2 Recommendations

- The banks of the artificial earthen channels that have been excavated to divert flow around the mining areas should be landscaped to slopes exhibiting a ratio of 1:3 (v:h) and revegetation with plugs from the surrounding wetland area. This will provide further filtration of the stormwater runoff and episodic flow through the channels and into the downstream Bronkhorstspruit River. Ideally, the existing wetlands on-site should be maintained at their base-line Present Ecological State score (PRES) by implementing rehabilitation and mitigation measures. This will increase the filtration of potentially harmful contaminants that may be present in the surface- and subsurface-flow that may be originating from the Leeuwpan Colliery.
- Toxicity testing of the water within the historic farm dam at 26° 10’ 00.22” S, 28° 42’ 41.98” E should be considered. This may further narrow the search for any

potential contamination sources on-site and create further measures of monitoring the potential impact on water quality within the downstream aquatic ecosystems.

- Clearing of Invasive Alien Plant Species (IAPS) from the aquatic ecosystems in areas under the control of the mine and associated with the reaches on which the affected biomonitoring points are situated to improve the water balance and natural biodiversity within and around the system. The controlling and maintenance of all IAPS on a land owner portion is a legal requirement in terms of the National Environmental Management: Biodiversity Act (Act no. 10 of 2004) Alien and Invasive Species List, 2016 (DEA, 2016).
- Ongoing monitoring of the aquatic community integrity, that is implemented at the Leeuwpan Colliery, should be maintained.
- The results presented within this biannual 2020 dry season aquatic assessment of the biomonitoring points associated with the Leeuwpan Colliery must be spatially and temporally compared to the results obtained during previous and future dry season biomonitoring studies. If the comparison highlights any significant alteration in the health/integrity of the at-risk or downstream aquatic ecosystems, the cause, extent and significance of the impact must be identified and appropriate mitigation and/or rehabilitation measures implemented to improve the health of the impacted systems.

5.4.4 Waste Monitoring

In terms of the waste monitoring that is performed on site, a risk management approach is adopted. Continuous assessments are also performed i.e. audits, in order to assess the performance of the waste management on site. After the evaluation and the necessary controls have been set up to eliminate wastages, the environmental management have to ensure continuity and follow up:

- Issue based assessments regarding Waste Management, when required;
- Continuous assessments regarding Waste Management;
- Training and education with regards to the Waste Management;
- PPE (application, availability, types, usage, and costs);
- Purchasing standards with regards to waste producing equipment and machinery;
- Periodic review of the Base Line Risk Assessment regarding Waste; and
- Periodic review of this procedure.

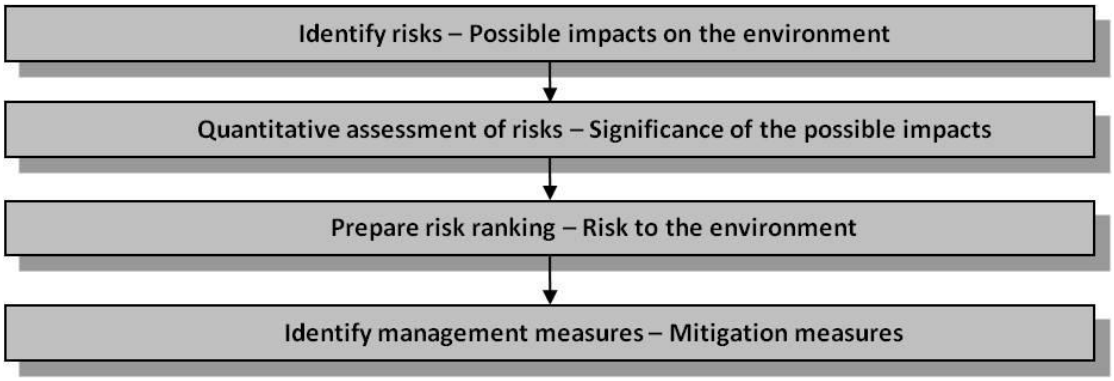
All necessary tests are carried out by the contracted waste removal company.

5.5 Risk Assessment/Best Practice Assessment

To ensure uniformity, the assessment of potential impacts was addressed in a standard manner so that a wide range of impacts is comparable. For this reason, a clearly defined rating scale was provided to the specialist to assess the impacts associated with their investigation.

Each impact identified was assessed in terms of probability (likelihood of occurring), scale (spatial scale), magnitude (severity) and duration (temporal scale). To enable a scientific approach to the determination of the environmental significance (importance), a numerical value will be linked to each rating scale.

The following process was followed:



The following methodology was used to rank potential impacts. Clearly defined ranking scales were used to assess the impacts associated with the proposed activities.

Each impact identified was rated according the expected magnitude, duration, scale and probability of the impact (refer to Table 5.13). Each impact identified was assessed in terms of scale (spatial scale), magnitude (severity) and duration (temporal scale). Consequence is then determined as follows:

Consequence = Severity + Spatial Scale + Duration

The Risk of the activity is then calculated based on frequency of the activity and impact, how easily it can be detected and whether the activity is governed by legislation. Thus:

Likelihood = Frequency of activity + frequency of impact + legal issues + detection

The risk is then based on the consequence and likelihood.

Risk = Consequence x likelihood

In order to assess each of these factors for each impact, the ranking scales in Table 5.6 to Table 5.12 were used.

Table 5.6 Severity

Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3
Great / harmful	4
Disastrous / extremely harmful / within a regulated sensitive area	5

Table 5.7 Spatial Scale - How big is the area that the aspect is impacting on?

Area specific (at impact site)	1
Whole site (entire surface of site)	2
Local (within 5km)	3
Regional / neighbouring areas (5km to 50km)	4
National	5

Table 5.8 Duration

One day to one month (immediate)	1
One month to one year (Short term)	2
One year to 10 years (medium term)	3
Life of the activity (long term)	4
Beyond life of the activity	5

Table 5.9 Frequency of the activity - How often do you do the specific activity?

Annual or less	1
Bi-annually	2
Monthly	3
Weekly	4
Daily	5

Table 5.10 Frequency of the incident/impact - How often does the activity impact the environment?

Almost never / almost impossible / >20%	1
Very seldom / highly unlikely / >40%	2
Infrequent / unlikely / seldom / >60%	3
Often / regularly / likely / possible / >80%	4
Daily / highly likely / definitively / >100%	5

Table 5.11 Legal issues - How is the activity governed by legislation?

No legislation	1

Fully governed by legislation	5

Table 5.12 Detection - How quickly/easily can the impacts/risks of the activity be detected on the environment, people and property?

Immediately	1
Without much effort	2
Need some effort	3
Remote and difficult to observe	4
Covered	5

Environmental effects will be rated as either of high, moderate or low significance on the basis provided in Table 5.13.

Table 5.13 Impact Ratings

Rating	Class
1-55	(L) Low Risk
56 – 169	(M) Moderate Risk
170 - 600	(H) High Risk

No specialist findings have been modified by the Consultant. The information provided within this report reflects the opinion of the specialists, in agreement with the Consultant. The applicant has reviewed all the conditions.

The rating of the identified impact associated with the two boreholes and the associated mitigation measures proposed are provided in Table 5.14. The impacts relating to the rest of the mining area are submitted annually as part of the required IWWMP updates and were authorised as part of the original application and licenses issued.

Table 5.14 Impacts and Management Measures

Impact description					Significance before mitigation	Significance after mitigation	Mitigation measures	Responsible Person
No.	Phases	Activity	Aspect	Impact				
1	Operation	Groundwater Abstraction from WK-BH1	Lowering of groundwater levels	Lowering of regional groundwater levels within the dolomitic aquifer	M	M	Adhere to pumping schedule and amendment of schedule by hydrogeologist, if necessary. Monitoring of the groundwater levels and quality of the surrounding monitoring boreholes and the production and reserve boreholes.	On site environmental representative
2	Operation	Groundwater Abstraction from WK-BH2	Lowering of groundwater levels	Lowering of regional groundwater levels within the dolomitic aquifer	M	L	Adhere to pumping schedule and amendment of schedule by hydrogeologist, if necessary. Monitoring of the groundwater levels and quality of the surrounding monitoring boreholes and the production and reserve boreholes.	On site environmental representative

5.6 Issues and Responses from Public Consultation Process

Public participation is an essential and legislative requirement for any environmental authorisation process. The principles that demand communication with society at large are best embodied in the principles of the National Environmental Management Act 1998 (Act No. 107 of 1998) (NEMA), South Africa's overarching environmental law.

Section 41 (4) of the NWA provides that the competent authority, the DWS, may, at any stage of the application process, require the applicant to place a suitable notice in newspapers and other media, and to take other reasonable steps as directed by the competent authority to bring the application to the attention of relevant organs of state, interested persons and the general public. The required Public Participation Process (PPP) is outlined in the Government Notice Regulation 267, Regulations Regarding the Procedural Requirements for Water Use Licence Applications and Appeals published in Government Gazette 40713 on 24 March 2017.

As such, the following PPP will be undertaken for this WULA in accordance with GNR.267:

- Erecting of Site Notices (English and isiZulu) on the 5th March 2021;
- Distribution of Background Information Documents (BIDs) to adjacent landowners, the respective local governments and any other Interested and Affected Party (I&AP) on the 5th March 2021 (via email); and
- Placement of an advertisement in two local newspapers (Highveld Chronicle and Streek Nuus) on the 5th March 2021.

The PPP will commence on the 5th March 2021 and will run for 60 days ending on the 6th May 2021. A full PP report will be compiled to include all responses from the public after the 60 day period.

5.7 Matters Requiring Attention/Problem Statement

Not applicable to this application.

5.8 Assessment of Level and Confidence of Information

All information contained in this WULA was sourced from the following:

- Specialist studies conducted for the project area which include:
    - Envass – Aquatic Assessment;
    - GCS – Hydrogeological Investigation;
    - Envass – Monthly Water Quality Report; and
    - Exxaro – Integrated Water Balance Report for Leeuwpan Mine.
- The 2019 IWWMP Update conducted by GCS;

- The EIA / EMP consolidation compiled and submitted to the DMR and the MDEDET for the expansion project; and
- Previous environmental reports conducted for the Leeuwpan Mine.

The specialists appointed to undertake the various investigations are considered to be competent in their particular fields. In light of the above, the level of confidence with regards to the information and reports used to compile this document is high.

6 WATER AND WASTE MANAGEMENT

6.1 Water and Waste Management Philosophy

The project policy of Leeuwpan Coal is to provide a benchmark for its employees, customers and contractors to meet the highest standards and make every effort to conform to all legal requirements including all set key performance objectives.

Leeuwpan Coals project management philosophy is to continually improve the project execution performances of their project activities and to set objectives so as to reduce risks associated with those actions.

The Directors and the project team are wholly committed to a safe, accident free working environment and must endeavour to show continual improvement in employee safety and health.

The company should make effort to ensure that safety, health and environmental legislation and regulations are complied with, in execution of project activities.

The project team should continually improve the quality of actions to ensure that key performance objectives are met.

6.1.1 Process Water

The philosophy with respect to process water management is to:

- Minimise the amount of process water produced (continually investigate emerging technologies for processing);
- Contain all process water to ensure zero discharge to the environment; and
- Re-use process water for dust suppression and in the process.

6.1.2 Storm Water

The philosophy for stormwater management on site is in keeping with the GN704 principles:

- To keep clean and dirty water separated;
- To contain any dirty water within a system;
- To prevent contamination of clean water; and
- To return clean water to the catchment.

6.1.3 Groundwater

The philosophy for waste management of groundwater is:

- Ensure that all potential groundwater impacts are identified; and
- Ensure that groundwater monitoring is conducted quarterly and that records are kept and a database compiled to identify trends over time.

6.1.4 Waste

The philosophy for the management of the various waste streams on site is:

- Minimisation of waste through reducing, re-using and recycling of waste;
- Monitoring of waste management practises;
- Best practise storage and disposal of waste; and
- Consideration of alternative cost effective technologies with regards to waste Management.

6.2 Strategies

The following strategies have been outlined and implemented for Leeuwpan.

6.2.1 Process Water

Process water management will consist of:

- Investigating new alternatives for process water treatment and re-use; and
- Continued, regular monitoring of dirty water dams which contain process water to ensure that the water quality is appropriate for re-use.

6.2.2 Storm Water

A storm water management plan should be developed and updated for Leeuwpan operations. Storm water management will comprise of:

- Regular monitoring of surface water quality; and
- Regular monitoring and maintenance of stormwater control structures.

6.2.3 Groundwater

Groundwater management strategies will comprise of:

- Continued, regular monitoring of groundwater levels and quality; and
- Annual compliance audits.

6.2.4 Waste

Waste management strategies will consist of:

- Implementation of good housekeeping and best practises;
- Investigating new, cleaner and more cost effective technologies to reduce and manage waste;
- Monitor compliance with best practises; and
- Creating environmental awareness and sensitivity through improvements to the induction programme for employees.

6.3 Performance Objectives/Goals

The following objectives and strategies are followed in order to achieve the Safety, Health, Environment and Community Policy:

- Compliance:
    - Identify all applicable legislation and other applicable requirements to the identified environmental aspects and ensure that the operations remain in compliance with such legislation and requirements.
- Pollution Prevention:
    - Identify the impacts that all operations, processes and products have on the environment and will ensure that pollution on the environment is prevented or minimised.
- Improvement:
    - Set objectives and targets to improve environmental performance and the Environmental Management System and will continually strive to find even better sustainable solutions to problems.
- Competence:
    - Ensure that all people who perform work for or on behalf of Leeuwpan Coal are competent and understand the impact of their activities on the environment, and their role in the prevention of pollution and the maintenance of the Environmental Management System.
- Communication:

- Actively communicate this policy to persons working for and on behalf of Leeuwpan Coal to ensure that they understand the content intent and will make it available to the public.

- Review:
  - Review the continued sustainability and adequacy of this policy at least annually to ensure it remains valid at all times.

6.4 Measures to Achieve and Sustain Performance Objectives

The water resource can be protected in the following ways by applying water conservation, pollution prevention and minimisation of impacts principles:

- Reduction in the level of contamination of water through implementation of pollution prevention strategies thereby increasing the economic reuse of the water without treatment; and
- Minimisation of impacts through capture, containment, reuse & reclamation of contaminated water thereby preventing discharges/releases.

6.5 Option Analysis and Motivation for Implementation of Preferred Options

No alternative sources of water have been investigated for this project as the groundwater from the borehole has been utilised by the mine for many years and is being licensed at the request of DHSWS.

6.6 Leeuwpan's IWWMP Action Plan

Leeuwpan is a current mining operation and an action plan has been identified and implemented for the water and waste management activities on site. Refer to Table 6.1 for the current Leeuwpan IWWMP Action Plan.

Table 6.1 Leeuwpan's IWWMP Action Plan

	Action	Implementation Date	Person Responsible
1	Appoint a qualified groundwater specialist & undertake quarterly groundwater monitoring	Operational Phase (Ongoing)	Environmental Specialist
2	Maintain/update centralised monitoring database (for surface water and groundwater)	Operational Phase (Ongoing)	Environmental Specialist
3	Undertake concurrent and final rehabilitation in accordance with the approved Rehabilitation Plan (as per the EMP)	Operational Phase (Ongoing)	Engineering Manager/Environmental Specialist
4	Maintain a relationship with surrounding groundwater users to determine if there are any potential issues	Operational Phase (Ongoing)	Environmental Specialist/Human Resources Manager

	Action	Implementation Date	Person Responsible
6	Compile and implement a maintenance schedule for the stormwater management infrastructure	Operational Phase (Ongoing)	Environmental Specialist
7	Include the regular inspection and maintenance of fences in the maintenance schedule	Operational Phase (Ongoing)	Environmental Specialist
10	Conduct weekly inspection along conveyor route and maintain conveyor on a regular basis	Operational Phase (Ongoing)	Engineering manager
11	Clean up spillages when they occur	Operational Phase (Ongoing)	Engineering manager
12	Construct and maintain leakage detection structures	Ongoing - Monthly	Engineering Manager
13	Fence off wetlands and conduct induction to inform workers of no-go areas	Operational Phase	Mine Manager/Environmental Officer
14	Sampling sites should be located so that any contamination of water resources from the water management infrastructure can be rapidly identified and located. Emergency response procedures for failure of any water infrastructure on the mine should be established and regularly tested. All staff should be aware of the procedures and how to alert management of any failures	Ongoing	Environmental control Specialist/Project Manager
15	Silt traps should be installed upstream of all pollution control dams and dirty water storage dams to limit silt deposition in the dams. Dams should be inspected for siltation and cleaned (if necessary) before the start of every summer rainfall season	Ongoing	Environmental Specialist/Project Manager
16	The spillways and discharge points should be inspected for erosion damage at the end of every rainfall season and all erosion damage repaired.	Ongoing	Environmental Specialist/Project Manager
17	Dirty water should be re-used as far as possible within the mining operations	Ongoing	Environmental Specialist/Project Manager
18	Ensure the approved SWMP infrastructure have all been correctly constructed as per the updated SWMP.	Operational Phase	Contractor/Environmental Specialist
19	Implement inspection and maintenance schedule for river diversions	Monthly	Environmental Specialist
20	Maintenance and operation of clean and dirty water system and erosion control measures will be ensured at all times	Ongoing	Environmental Specialist/Project Manager
21	A dynamic water and salt balance will be drawn up and updated by the mine to reflect the operational activities.	Monthly	Environmental Specialist/Project Manager
22	Surface water quality sampling will be undertaken on a monthly basis and analysed according to the prescribed monitoring programme contained in the EIA/EMP.	Quarterly	Environmental control officer/Water Quality Specialist

	Action	Implementation Date	Person Responsible
23	Quarterly surface water monitoring reports will be generated by the mine or through a qualified water quality specialist.	Quarterly	Environmental control officer/Water Quality Specialist
24	In the event that water quality issues are identified based on the monitoring programme, an independent specialist should be consulted to determine the best course of action to ameliorate the situation.	In the event of occurrence.	Environmental control officer/Water Quality Specialist
25	Ensure that adequate storm water management measures and clean and dirty separation mechanisms are implemented on site.	Ongoing	Environmental control officer
26	Soil stored in stockpiles and used for the construction of surface water infrastructure and for rehabilitation will be monitored on a quarterly basis, increasing in frequency during the rainy season, so as to ensure that the soil conservation measures which have been implemented have been effective, and to highlight areas where soil management can be improved.	Ongoing	Environmental control officer/Project Manager
27	PCDs will be inspected regularly to monitor and mitigate the possibility of seepage.	Weekly	Environmental Control Officer/Project Manager
28	Dirty water will be contained in specially designated water holding facilities to minimise the volume of contaminated water seepage to the groundwater.	Ongoing	Environmental control officer/Project Manager
29	Implement recommendations as per GN 704 Audit 2016.	Ongoing	Environmental control officer/Project Manager

6.7 Control and Monitoring

6.7.1 Monitoring of Change in Baseline information

6.7.1.1 Surface Water Monitoring

Refer to Section 5.4.1 for the monitoring undertaken for surface water resources at Leeuwpan Mine.

6.7.1.2 Groundwater Monitoring

Refer to Section 5.4.2 for the monitoring undertaken for groundwater resources at Leeuwpan Mine.

6.7.1.3 Biomonitoring

Refer to Section 5.4.3 for the biomonitoring undertaken at Leeuwpan Mine.

6.7.1.4 Wetland Monitoring

Refer to Section 5.4.4 for the wetland monitoring undertaken at Leeuwpan Mine.

6.7.2 Audit and Report on Performance Measures

Each component within the WUL has an associated audit and performance review component. Regular review and auditing is important to ensure systems are up-to-date and still relevant for current situations. Evaluation is required to verify its appropriateness and suitability by comparing performance to objectives set. Changes or adjustments to systems are required where review/auditing highlights shortcomings or gaps. Performance should be measured against:

- Internal audit (conducted annually);
- External audit (conducted annually); and
- DHSWS reporting (conducted bi-annually).

7 CONCLUSION

7.1 Regulatory Status of Activity

There are currently three Water Use Licences for the Leeuwpan mining operation. The IWULs that pertains to this report were issued in 2011 (Licence No. 04/B21A/ABCGIJ/429) and its associated amendment, as well as the IWUL for the OI and OL expansion (Licence No. 04/B20A/CIJ/4032) that was issued in 2015 for the current, existing and future mining operations. An additional IWUL (Licence No. 06/B20A/CI/9521) was issued for the expansion of mining Block OI to include the area where planned infrastructure would have originally been located. This expansion area is referred to as OI West.

Furthermore, following a meeting with the DHSWS, the DHSWS indicated that Leeuwpan requires authorisation in the form of a Water Use License (WUL) for the abstraction of water from the Witklip borehole (WK-BH1) for operations at the Leeuwpan Coal Mine. This borehole was not licensed as part of the authorisations previously issued and was previously been listed as an Existing Lawful Water Use (ELWU) in previous reports. DHSWS have however, requested that an application be made to license this abstraction. In addition, a second borehole (WK-BH2) is being applied for as a backup supply borehole to supplement Witklip borehole 1 water if water cannot be abstracted from it. Abstraction of water from the two boreholes triggers a water use in terms of Section 21(a) ‘taking water from a water resource’ of the NWA.

The WK-BH1 and WK-BH2 are not licensed as part of the IWULs issued and as a result is being applied for in this application.

7.2 Statement of Water Use Requiring Authorisation

As a result of the need for abstraction of water from the WK-BH1 and the back-up WK-BH2 this water use is being applied for as a Section 21(a) water use in terms of the requirements of the NWA. For this abstraction, a monitoring programme will be implemented and has been discussed in this document. This is to ensure that all conditions of the water licence are met and that the receiving environment is not adversely affected by the two boreholes.

7.3 Section 27 Motivation

Refer to Annexure A for the Section 27 Motivation compiled for the two boreholes.

7.4 Proposed License Conditions

It is hereby recommended that the water use be authorised under a water use licence issued by the DHSWS for a period of 15 years with a review period of 5 years.

8 REFERENCES

Department of Water and Sanitation, DWS. (2013). Groundwater Resource Directed Measures (GRDM). Version 2.3.2.

Environmental Authorisation and Environmental Management Plan reports compiled for the Block OI Expansion project.

Specialist Studies conducted for the Leeuwpan monitoring programme.

Specialist Studies conducted for the Block OI Expansion project.

Victor Khanye Local Municipality. (2020). Victor Khanye Local Municipality Integrated Development Plan Final 2019/20 Review.

Annexure A
Section 27 Motivation

GCS
Water & Environmental Consultants

63 Wessel Road, Rivonia, 2128 PO Box 2597, Rivonia, 2128 South Africa
Tel: +27 (0) 11 803 5726 **Fax:** +27 (0) 11 803 5745 **Web:** www.gcs-sa.biz

Section 27 Motivation

National Water Act, 1998 (Act No. 36 of 1998)

Report

Version – Public Review

04 March 2021

Exxaro Leeuwpan

GCS Project Number: 20-1014

Client Reference: PO: 4512334972



Section 27 Motivation

Report
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Exxaro Leeuwpan

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CONTENTS PAGE

1 EXISTING LAWFUL WATER USE 1
2 THE NEED TO REDRESS THE RESULTS OF PAST RACIAL AND GENDER DISCRIMINATION 7
2.1 PROCUREMENT 7
2.2 EMPLOYMENT EQUITY 8
2.3 WOMEN IN MINING 9
2.4 SKILLS DEVELOPMENT PLAN 9
2.5 MENTORSHIP PLAN 11
2.6 INTERNSHIP AND BURSARY PLAN 12
3 EFFICIENT AND BENEFICIAL USE OF WATER IN THE PUBLIC INTEREST 12
4 THE SOCIO ECONOMIC IMPACT 15
4.1 OF THE WATER USE OR USES IF AUTHORISED 15
4.1.1 The Social Impact: 15
4.1.2 Economic Impact 15
4.2 OF THE FAILURE TO AUTHORISE THE WATER USE OR USES: 16
5 ANY CATCHMENT MANAGEMENT STRATEGY APPLICABLE TO THE RELEVANT WATER RESOURCE 16
6 THE LIKELY EFFECT OF THE WATER USE TO BE AUTHORISED ON THE WATER RESOURCE AND ON OTHER WATER USERS 17
6.1 SURFACE WATER 17
6.2 GROUNDWATER 17
7 THE CLASS AND THE RESOURCE QUALITY OBJECTIVES OF THE WATER RESOURCE 18
7.1 RECEIVING WATER QUALITY OBJECTIVES AND THE RESERVE 19
8 INVESTMENTS ALREADY MADE AND TO BE MADE BY THE WATER USER IN RESPECT TO THE WATER USE IN QUESTION 19
9 THE STRATEGIC IMPORTANCE OF THE WATER USES TO BE AUTHORISED 20
10 THE QUALITY OF WATER IN THE WATER RESOURCE WHICH MAY BE REQUIRED FOR THE RESERVE AND FOR MEETING INTERNATIONAL AGREEMENTS 21
10.1 INTERNATIONAL AGREEMENTS 21
10.2 SURFACE WATER QUALITY 21
10.2.1 Receiving Environmental Water Quality 21
10.2.2 Process Water Quality 22
10.2.3 Effluent Water Quality 23
10.2.4 Potable Water Quality 23
10.2.5 Conclusion and Aspects to Consider 23
10.3 GROUNDWATER QUALITY 25
11 THE PROBABLE DURATION OF ANY UNDERTAKING OR WHICH A WATER USE IS TO BE AUTHORISED 27
12 REFERENCES 28

LIST OF TABLES

Table 1.1 Existing Lawful Water Uses under Section 21 1
Table 1.2 Existing Approved Water Uses 2
Table 2.1 Women in mining – Five year project projection 9
Table 7.1 Resource classes as set out by the DWS 18
Table 7.2 Resource classes for the Bronkhorstspruit 19
Table 7.3 System variables (DWA 2001) 19

LIST OF FIGURES

Figure 10.1 Expanded Durov diagram of groundwater chemistry regarding March 2020 (Envass, 2020) 26
Figure 10.2 Stiff diagrams of groundwater chemistry regarding September 2020 (Envass, 2020)..... 27

1 EXISTING LAWFUL WATER USE

Existing Lawful Water Use (ELWU) is defined in Section 32 of the National Water Act 1998, (Act No. 36 of 1998) (NWA) as any water use which has taken place at any time during a period of two years immediately before the date of commencement of the NWA. It also includes any water use which has been declared an existing lawful water use under Section 33 and which was authorised by or under any law which was in force immediately before the date of commencement of the NWA.

As Leeuwpan Coal has been operational since 1992, several of the Water Use activities at the mine commenced before the promulgation of the NWA, 1998. The ELWUs undertaken at the Existing Leeuwpan Coal Mine in terms of section 21 of the NWA are listed in Table 1.1 below.

Table 1.1 Existing Lawful Water Uses under Section 21

Property Name	Section 21	Description	Date Commenced
Witklip 229 IR, Portion 4	(a)	Witklip Borehole abstraction	1994
Witklip 229 IR, Portion 4	(c) & (i)	River diversion. Permit B187/1/220/6 in terms of Section 20 (1)(a) of the Water Act, (Act 54 of 1956).	1993
Witklip 229 IR, Portion 6	(c) & (i)	River diversion. Permit B187/1/220/6 in terms of Section 20 (1)(a) of the Water Act, (Act 54 of 1956).	1993
Witklip 229 IR, Portion 16	(c) & (i)	River diversion. Permit B187/1/220/6 in terms of Section 20 (1)(a) of the Water Act, (Act 54 of 1956).	1993
Kenbar 257 IR	(g)	Domestic wastewater disposal	1994
	(g)	In-pit backfilling.	1992
	(g)	Disused Slimes dams No. 1,2 and 3	1994
	(g)	Plant raw water dams.	1992
	(g)	Workshop raw water tank.	1992
Leeuwpan 246 IR	(g)	Domestic Waste Disposal	1994
	(g)	Load out Evaporation Dam	1992
Witklip 229 IR, Portion 4	(g)	Witklip evaporation dam.	1994
Witklip 229 IR, Portion 4	(j)	Pit Dewatering	1992
Kenbar 257 IR	(j)	Pit Dewatering	1992

Leeuwpan mine have also been issued with three licences from the Department of Water and Sanitation (DWS). The licences issued are as follows:

- Licence No. 04/B21A/ABCGIJ/429 issued on the 25th March 2011. An amendment to the IWUL was also issued in terms of section 50 and section 158 of the NWA on the 18 December 2015;
- Licence No. 04/B20A/CIJ/4032 issued on the 18th December 2015. The licence was issued for the proposed expansion mining activities in Block OI and OL; and

- Licence No. 06/B20A/CI/9521 issued on the 4th March 2020. The licence was issued for the expansion of mining Block OI to include the area where planned infrastructure would have originally been located. This expansion area is referred to as OI West.

The ELWUs listed in Table 1.1 were included in the licence that was issued in 2011 (Licence No. 04/B21A/ABCGIJ/429).

Refer to Table 1.2 for all of the licenced water uses as per the issued IWUL (Licence No. 04/B21A/ABCGIJ/429) and its associated Amendment issued in 2015.

Table 1.2 Existing Approved Water Uses

Water Uses - Leeuwpan Mine (04/B21A/ABCGIJ/429) Including 18th December 2015 Amendments				
Section 21(a)	**Site Name**	**Co-ordinates**	**Property**	**Volume Licenced**
Taking of water from a Borehole	Borehole	26°55'07.7"S 29°36'04.0"E	Kenbar 257 IR	68400m³
Abstraction of waste water from Block OD	Block OD	26°10'41.6"S 28°43'26.3"E	Kenbar 257 IR	226 992m³/a
Abstraction of waste water from Block OM	Block OM	S26°10'24.2" E28°44'58.4"	Kenbar 257 IR	20000m³/a
Abstraction of waste water from Block OH	Block OH	S26°10'24.2" E28°44'58.4"	Kenbar 257 IR	26400m³/a
Abstraction of waste water from Block OJ	Blovk OJ	S26°09'49.2" E28°45'45.2"	Moabsvelden 248 IR	292000m³/a
Abstraction of waste water from Block OWM	Block OWM	S26°09'49.2" E28°45'45.2"	Moabsvelden 248 IR	31880m³/a
Section 21(b)	**Site Name**	**Co-ordinates**	**Property**	**Capacity m³**
Low Lying Area 2: Storage capacity varying circular unlined	Low Lying Area 2	26°11'09.8"S 28°42'33.1"E	Wolvenfontein 244 IR	188 000
Section 21(c) and (i)	**Property**			
Block OWM River diversion – Weltevreden tributary of the Bronkhorstspruit	Moabsvelden 248 IR & Weltevreden 227 IR			
Section 21(g)	**Site Name**	**Co-ordinates**	**Property**	**Capacity / Size / Area/ Volume Licenced (m³/a)**
Dirty runoff and process water used for dust suppression	Dust Suppression	26°10'45.4"S 28°43'58.0"E	Kenbar 257 IR	6 552
Disposing of waste into the pollution control dam in a manner which may detrimentally impact on a water resource - Septic tank (all these tanks are transported via honey sucker to the 7m³ STP located at the mining green area	Septic Tank 1	26°10'53.1"S 28°44'20.4"E	Kenbar 257 IR	10m³
Disposing of waste into the pollution control dam in a manner which may detrimentally impact on a water resource - Septic tank (all these tanks are transported via honey sucker to the 7m³ STP located at the mining green area	Septic Tank 2	26°10'54.8"S 28°44'17.5"E	Kenbar 257 IR	10m³
Disposing of waste into the pollution control dam in a manner which may detrimentally impact on a water resource	Septic Tank 3	26°10'55.4"S 28°44'18.5"E	Kenbar 257 IR	10m³

- Septic tank (all these tanks are transported via honey sucker to the 7m³ STP located at the mining green area				
Disposing of waste into the pollution control dam in a manner which may detrimentally impact on a water resource - Septic tank (all these tanks are transported via honey sucker to the 7m³ STP located at the mining green area	Septic Tank 4	26°10'56.2"S 28°44'16.9"E	Kenbar 257 IR	10m³
Disposing of waste into the pollution control dam in a manner which may detrimentally impact on a water resource - Septic tank (all these tanks are transported via honey sucker to the 7m³ STP located at the mining green area	Septic Tank 5	26°10'57.7"S 28°44'20.2"E	Kenbar 257 IR	10m³
Disposing of waste into the pollution control dam in a manner which may detrimentally impact on a water resource - Septic tank (all these tanks are transported via honey sucker to the 7m³ STP located at the mining green area	Septic Tank 6	26°11'09.2"S 28°43'46.4"E	Kenbar 257 IR	10m³
Disposing of waste into the pollution control dam in a manner which may detrimentally impact on a water resource - Septic tank (all these tanks are transported via honey sucker to the 7m³ STP located at the mining green area	Septic Tank 7	26°11'06.4"S 28°43'36.5"E	Kenbar 257 IR	10m³
Disposing of waste into the pollution control dam in a manner which may detrimentally impact on a water resource - Septic tank (all these tanks are transported via honey sucker to the 7m³ STP located at the mining green area	Septic Tank 8	26°11'08.4"S 28°43'36.5"E	Kenbar 257 IR	10m³
Disposing of waste into the pollution control dam in a manner which may detrimentally impact on a water resource - Septic tank (all these tanks are transported via honey sucker to the 7m³ STP located at the mining green area	Septic Tank 9	26°11'08.4"S 28°43'37.3"E	Kenbar 257 IR	10m³
Disposing of waste into the pollution control dam in a manner which may detrimentally impact on a water resource - Septic tank (all these tanks are transported via honey sucker to the 7m³ STP located at the mining green area	Septic Tank 10	26°11'10.2"S 28°43'38.1"E	Kenbar 257 IR	10m³
Disused Slimes Dam 1 & 2 that are lined with composite lining	Slimes Dams 1 & 2	26°10'58.6"S 28°43'53.4"E	Kenbar 257 IR	Footprint Area = 2.1Ha Height = 2.5m Length = 40m Breadth = 15m Volume = 88800m³
Disused Slimes Dam 3 that are lined with composite lining	Slimes Dam 3	26°10'58.6"S 28°43'53.4"E	Kenbar 257 IR	Footprint Area = 1.4Ha Height = 2.5m Length = 40m Breadth = 15m Volume = 111 500m³
Plant reuse raw water dam compartment 1 - collects contaminated water from the Witklip evaporation Dam, mobile pit water tank, washbay low lying area and Block OD	Raw Water Dam Compartment 1	26°10'52.9"S 28°43'51.6"E	Kenbar 257 IR	Footprint Area = 2.1Ha Height = 2.7m Length = 10m Breadth = 10m Volume = 51 000m³

Plant reuse raw water dam compartment 2 - collects contaminated water from the Witklip evaporation Dam, mobile pit water tank, washbay low lying area and Block OD	Raw Water Dam Compartment 2	26°10'48.9"S 28°43'51.0"E	Kenbar 257 IR	Footprint Area = 2.2Ha Height = 2.6m Length = 10m Breadth = 10m Volume = 55 000m³
Wash bay low laying area - the low lying area collects clear water from the oil separator at the workshop & washbay as well as runoff from the washbay for reuse at the washbay or its pumped to the plant raw water dams – unlined	Wash bay low laying area	26°10'55.4"S 28°44'16.0"E	Kenbar 257 IR	Footprint Area = 0.6Ha Height = 0.5m Length = 250m Breadth = 100m Volume = 3007m³
Mobile pit water tank - this tank collects contaminated water pumped from the open pits and is pumped to the plant raw water dams - steel tank	Mobile pit water tank	26°10'24.9"S 28°44'30.0"E	Kenbar 257 IR	Footprint Area = 0.003Ha Height = 2m Length = 6m Breadth = 6m Volume = 60m³
Process water storage tank 3 - process water from the plant is stored in this tank - steel tank	Process water storage tank 3	26°10'21.7"S 28°43'51.0"E	Kenbar 257 IR	Footprint Area = 0.035Ha Height = 3m Length = 0m Breadth = 0m Volume = 1050m³
Process water storage tank 4 - process water from the plant is stored in this tank - steel tank	Process water storage tank 4	26°10'21.7"S 28°43'51.0"E	Kenbar 257 IR	Footprint Area = 0.023Ha Height = 4.7m Length = 0m Breadth = 0m Volume = 1081m³
Plant raw water tank 1 - contaminated water from the plant raw water dams are stored in this dam for reuse - steel tank	Plant raw water tank 1	26°10'21.7"S 28°43'51.0"E	Kenbar 257 IR	Footprint Area = 0.007Ha Height = 2.5m Length = 0m Breadth = 0m Volume = 166m³
Workshop Raw Water Tank - this tank stores contaminated water from the plant raw water dams for use at the wash bay - steel tank	Workshop raw water tank	26°10'54.3"S 28°44'18.8"E	Kenbar 257 IR	Footprint Area = 0.003Ha Height = 2m Length = 0m Breadth = 0m Volume = 60m³
In-pit backfilling - disposal of plant discard from filter press and over burden into the open pits. Front pit area > total area of property on which waste is disposed	In-pit backfilling	26°10'19.7"S 28°42'45.6"E	Kenbar 257 IR	Footprint Area = 1548Ha Volume = 6 432 m³/d
Low Lying Area 1 - this was an internal catchment area that exists as a result of the location of the infrastructure and the pits at Blocks OH, OM and OD. Only clean runoff was contained in this area. The water surface area at full supply level is 9.5 Hectares. But the area has in the meantime been cleaned up, and filled and compacted to be used as product stockpile area. This will be used to contain run-off water from product stockpile beds.	Low Lying Area 1 - Product Stockpile Area	26°10'21.7"S 28°43'51.0"E	Kenbar 257 IR	Footprint Area = 2.1Ha Height = 8m Length = 100m Breadth = 25m Volume = 30 000m³/a
Conservancy Tank 1 - linked to STP of 4m³ situated at plant offices	Conservancy Tank 1	26°10'19.6"S 28°43'47.4"E	Leeuwpan 246 IR	10m³
Conservancy Tank 2 - linked to STP of 4m³ situated at plant offices	Conservancy Tank 2	26°10'17.3"S 28°43'49.3"E	Leeuwpan 246 IR	10m³

Conservancy Tank 3 - linked to STP of 4m³ situated at plant offices	Conservancy Tank 3	26°10'18.8"S 28°43'50.7"E	Leeuwpan 246 IR	10m³
Conservancy Tank 6 - linked to STP of 4m³ situated at plant offices	Conservancy Tank 6	26°10'15.7"S 28°43'41.1"E	Leeuwpan 246 IR	10m³
Conservancy Tank 7 - cleaned by Honey Sucker and disposed into STP of 4m³ situated at plant offices	Conservancy Tank 7	26°10'17.5"S 28°43'39.9"E	Leeuwpan 246 IR	10m³
Conservancy Tank 8 - cleaned by Honey Sucker and disposed into STP of 4m³ situated at plant offices	Conservancy Tank 8	26°10'24.5"S 28°43'40.7"E	Leeuwpan 246 IR	10m³
Conservancy Tank 16 - cleaned by Honey Sucker and disposed into STP of 4m³ situated at plant offices	Conservancy Tank 16	26°10'22.5"S 28°43'40.6"E	Leeuwpan 246 IR	10m³
Conservancy Tank 19 - cleaned by Honey Sucker and disposed into STP of 4m³ situated at plant offices	Conservancy Tank 19	26°09'57.8"S 28°43'47.8"E	Leeuwpan 246 IR	10m³
Package Sewage Treatment Plant	Package Sewage Treatment Plant	26°10'52.4"S 28°44'22.2"E	Kenbar 257 IR	7m³
Package Sewage Treatment Plant	Package Sewage Treatment Plant	26°92553"S 28°95365"E	Kenbar 257 IR	4m³
Plant Pollution Control Dam - the dam collects runoff from the plant and the coal product stockpiles that is used for dust suppression - Lined Dam, composite lining system	Plant Pollution Control Dam	26°10'02.8"S 28°43'28.5"E	Leeuwpan 246 IR & Wolvenfontein 244 IR	Ha Coverage = 2.1 Ha Height = 1.7m Length = 200m Breadth = 100m Volume = 90 000m³
Load Out Evaporation Dam - Direct rainfall at the load-out station is collected and left out to evaporate - not lined	Load Out Evaporation Dam	26°09'49.2"S 28°43'51.6"E	Leeuwpan 246 IR	Ha Coverage = 0.5Ha Height = 1.5m Length = 25m Breadth = 50m
Process Water Storage tank 1 - Process water tank 1 stores process water used at the plant - steel tank	Process Water Storage Tank 1	26°10'15.6"S 28°43'41.7"E	Leeuwpan 246 IR	Intake Water = 5328 and 20 000 m³ Ha Coverage = 0.038Ha Height = 3m Vol. Used = 1140 m³
Process Water Storage tank 2 - Process water tank 2 stores process water used in the plant - steel tank	Process Water Storage Tank 2	26°10'15.6"S 28°43'41.7"E	Leeuwpan 246 IR	Intake Water = 5328 and 20 000 m³ Ha Coverage = 0.038Ha Height = 3m Vol. Used = 1140 m³
Plant Raw Water Tank 2 - the tank stores contaminated water from the plant raw water dams for reuse at the plant - steel tank	Plant Raw Water Tank 2	26°10'15.6"S 28°43'41.7"E	Leeuwpan 246 IR	Intake Water = 5328 and 20 000 m³ Ha Coverage = 0.0063Ha Height = 4.7m Vol. Used = 296 m³
Jig Thickener Dam - contains water from the Jig Plant dirty water management system -Steel Dam	Jig Thickener Dam	26°10'14.5"S 28°43'41.6"E	Leeuwpan 246 IR	Ha Coverage = 0.00236Ha Height = 4.5m Vol. Used = 740 m³
Jig Clarified Dam - contains water from the Jog plant water management system - Steel Dam	Jig Clarified Dam	26°10'14.5"S 28°43'41.6"E	Leeuwpan 246 IR	Intake Water = 3 000 m³ Ha Coverage = 0.00035Ha Height = 4.5m Vol. Used = 160 m³

Witklip Return Water Dam (Reg. 24059135) - process water from the plant is stored in this return dam. Sized to accept seepage from the under drainage system and decant system for up to 1:50 year rainfall event, over and above normal operating conditions	Witklip Return Water Dam	26°10'23.5"S 28°42'26.3"E	Witklip 229 IR	Intake Water = 5328 (a) and 20 000 m³ (j) Ha Coverage = 50Ha Height = 4m Length = 100m Breadth = 200m
Witklip Evaporation Dam - the dirty storm water collected in this dam is left to evaporate - Lined with clay - application made with Dam Safety Office	Witklip Evaporation Dam	26°10'23.5"S 28°42'26.3"E	Witklip 229 IR Ptn 4	Intake Water = 5328 (a) and 20 000 m³ (j) Ha Coverage = 3.3Ha Height = 5.9m Length = 50m Breadth = 50m
Section 21(j)	**Site Name**	**Co-ordinates**	**Property**	**Volume Licenced**
Abstraction of waste water from Block OD	Block OD	26°10'41.6"S 28°43'26.3"E	Kenbar 257 IR	226 992m³/a
Abstraction of waste water from Block OM	Block OM	S26°10'24.2" E28°44'58.4"	Kenbar 257 IR	20000m³/a
Abstraction of waste water from Block OH	Block OH	S26°10'24.2" E28°44'58.4"	Kenbar 257 IR	26400m³/a
Abstraction of waste water from Block OJ	Blovk OJ	S26°09'49.2" E28°45'45.2"	Moabsvelden 248 IR	292000m³/a
Abstraction of waste water from Block OWM	Block OWM	S26°09'49.2" E28°45'45.2"	Moabsvelden 248 IR	31880m³/a

2 THE NEED TO REDRESS THE RESULTS OF PAST RACIAL AND GENDER DISCRIMINATION

The paragraphs which follow hereunder will indicate how Leeuwpan addresses and facilitates the results of past racial and gender discrimination in the context of public policies.

Policy/Plan	Provision
South Africa's National Policy Framework for Women's Empowerment and Gender Equality	To promote a society in which women and men are able to realise their full potential and to participate as equal partners in creating a just and prosperous society for all.
The Broad Based Socio Economic Empowerment Charter for the South African Mining and Minerals Industry	The objectives of the Mining Charters is to: ➢ promote equitable access to the nation's mineral resources to all the people of South Africa; ➢ substantially and meaningfully expand opportunities for Historically Disadvantaged South Africans (HDSA) to enter the mining and minerals industry and to benefit from the exploration of the nation's mineral resources; ➢ utilise and expand the existing skills base for the empowerment of HDSA; ➢ promote employment and advance the social and economic welfare of mine communities; ➢ promote beneficiation of South Africa's mineral communities; and ➢ promote sustainable development and growth of the mining industry.
A Beneficiation Strategy for the Minerals Industry of South Africa	The strategy outlines a framework that will enable an orderly development of the country's mineral value chains, thus ensuring South Africa's mineral wealth is developed to its full potential and to the benefit of the entire population.
Minerals and Mining Policy for South Africa	Equitable access to all natural resources is required, based on economic efficiency and sustainability. The creation of wealth and employment is required for the economic empowerment of communities, both directly and through the multiplier effect. This is especially relevant in the underdeveloped regions of the country.

Fundamentals of Leeuwpan's compliance with the abovementioned policies/strategies:

2.1 Procurement

Effective partnership is a requisite instrument to effect meaningful integration of HDSA into the mainstream economy. Leeuwpan aims to achieve a substantial change in racial and gender disparities prevailing in the sharing of mining assets and to pave the way for meaningful participation of HDSA for attainment of sustainable growth of the mining industry.

Leeuwpan is committed to the following preferential purchasing and procurement objectives:

- Creating an enabling environment for HDSA companies to do business with Leeuwpan;
- Ensuring that an increasing proportion of contracts are awarded to HDSA companies;

- Providing opportunities to businesses that implement their own proven economic empowerment programmes; and
- Creating awareness, understanding and support of economic empowerment objectives among key stakeholders.

Leeuwpan is dedicated to developing entrepreneurs in the informal business sector, which is the largest employer of people. To achieve the aforementioned, Exxaro has adopted the Business Incubator model to develop entrepreneurs and to overcome barriers to employment. The Business Incubator aims to develop the youth, the unemployed and to start up enterprises. The Incubator will provide support to entrepreneurs by means of operational business support and funding. The ultimate objective is to establish sustainable, financially and operationally independent businesses as a means to create jobs and grow the economy of the area.

To ensure the objective of increasing the number of HDSA SMME suppliers is met, capacity building initiatives as well as training and development are undertaken which enables small operators in the local area to become more efficient.

2.2 Employment Equity

Workplace diversity and equitable representation at all levels are catalysts for social cohesion, transformation and competitiveness of the mining industry.

In line with Exxaro's Employment Equity policy, Leeuwpan's broad objectives are to accelerate the training and promotion of designated groups and to create an environment of sustainable diversity through the implementation of Employment Equity programmes. In addition to the aforementioned, Leeuwpan strives to achieve the following:

- Preventing the existence of unfair discriminatory practices;
- Preventing sexual and racial harassment;
- Preventing the existence of barriers in the workplace which unfairly restrict employment and promotion opportunities of any person;
- Achieving an enhanced representation of underrepresented categories of people with the emphasis on individuals from designated groups, at all levels in the organisation, focused on the long-term objective of reflecting the demographics of the South African population; and
- Creating an organisational culture in which diversity is encouraged and valued while focusing on shared values in order to develop team spirit, promote mutual understanding, optimise potential and achieve organisational goals in serving the community.

2.3 Women in Mining

Leeuwpan aims to attract women to, and retain women in the mining industry and to encourage the active participation of women in the mines. Table 2.1 hereunder represents Leeuwpan's five year project projection to achieve successful participation of women in mining from 2015 - 2019.

Table 2.1 Women in mining – Five year project projection

Women in mining (Paterson bands)		Projection - 2019					
		African	Coloured	Indian	White	Total	%
F & E	Top & senior management	0	0	0	0	0	0
D	Middle management	6	0	0	2	8	40%
C	Junior management, non-managerial	24	1	1	3	29	19%
B	Semi-skilled	49	3	0	2	54	15%
A	Unskilled	8	0	0	0	8	50%
Total number of women		**87**	**4**	**1**	**7**	**99**	**15%**
Total number of employees = 640 in core operations (% based on core)							

2.4 Skills Development Plan

Leeuwpan's Skills Development Plan (hereinafter referred to as the "SDP") focuses on equipping employees with skills to promote their progression in the minerals industry and to develop into other fields and sectors according to their aspirations.

The objectives of the SDP are to ensure the availability of mining and or production operations specific skills and competencies of the workforce, as well as skilling of employees for portable skills that can be utilised by employees outside the life of mine in the mining or production industries.

2.4.1.1 Adult Basic Education and Training

Adult Basic Education and Training (ABET) training at Leeuwpan Coal will be delivered in line with Exxaro's ABET policy. The mine uses accredited training providers to do yearly assessments on ABET needs and this is incorporated into the annual workplace skills plan. The Learning Coordinator manages the ABET students and tracks and monitors progress against the WSP and shortcomings thereof.

The ABET Plan includes:

- Block release (sixteen weeks full-time) for ABET 1;
- Delivery by an accredited provider;
- Monthly meetings with all ABET students to determine needs and progress;
- Six monthly meetings with potential and lapsed ABET students, and with the unions, to motivate enrolment;
- Annual screening for new applicants;
- Identification of relevant foremen and production heads as mentors for the different ABET levels;
- Career progression planning for learners entering ABET 4;
- Monitoring of implementation by mine management; and
- Union support to continuously motivate and engage employees needing ABET training.

2.4.1.2 Learnerships

Leeuwpan supports the development of employees and the youth towards full or part qualifications. Learnerships are a full qualification. Employees can be developed as part of their career development through a learnership. Learnerships in the core and critical disciplines of mining necessitates the maintenance of a talent pipeline in identified and approved learnerships. For the talent pipeline, the unemployed youth are recruited and selected for development via learnerships.

For both employees and the youth, the Mining Qualifications Authority (MQA) seven step process is used to develop people through learnerships. When the unemployed youth have been developed they are not automatically guaranteed a position, but the benefit is that with completion of the programme they are in possession of a nationally accepted qualification that will make them marketable when applying for a job.

The budget for learners (unemployed youth) is guided by the minimum remuneration and conditions of the sectoral determination for learnerships which forms part of the Basic Conditions of Employment Act. Added to this is the cost for recruitment and selection, the institutional phase at a training provider (e.g. Colliery Training College (CTC), accommodation and travel where relevant and other personal requirements like a toolbox and Personal Protective Equipment (PPE) requirements. The average period in training for these learners is 24-30 months.

Employees selected and approved towards learnerships (18.1) receive the normal remuneration of the position for which they have been appointed while they are being trained. They are assessed through the MQA seven step process. Other costs involved are selection costs, assessment costs, and costs to the training provider for required institutional training.

Leeuwpan develops employees and the youth towards the core and critical disciplines of engineering, mining and plant learnerships. Opportunities are also offered to contractors based them meeting the entry requirements of the programme. Only accredited MQA providers are used.

2.5 Mentorship Plan

Leeuwpan has developed and is currently implementing a mentorship plan aimed at facilitating the developmental needs of its employees. Particular focus is placed on transfer of skills, knowledge and competencies to HDSA.

Mentorship will be used as one of the interventions to address a suitable socialisation programme for the induction of protégés into the new/anticipated managerial/leadership environment. Psychological preparation, acquisition of career management skills, and addressing the values, fears and aspirations of protégés are essential for the success of the programme.

Leeuwpan will facilitate the allocation of a mentor to all candidates in training as well as development schemes in order to guide employees through the career development processes.

Students and employees on formal training programs and in the talent pool will benefit from the mentoring process. The mentoring will be based on group mentoring, peer mentoring, external mentoring and also senior manager mentoring.
The benefits of the Mentorship Plan are that a trainee becomes:

- An appropriately trained and developed competent professional who can take responsibility for a wide range of engineering activities;
- A well-integrated professional who can contribute meaningfully to the profession;
- A professional who can ensure economic benefit;
- A professional who can contribute to the continuing mentorship of others; and
- A professional who renders a service to the community with integrity and who adheres to the professions code of conduct.

Mentorship will be managed formally through a deliberate, structured, and focused process at Leeuwpan. Mentorship will be used as one of the interventions to address a suitable socialization programme for the induction of trainees into the new/anticipated managerial/leadership environment. Psychological preparation, acquisition of career management skills, and addressing the values, fears and aspirations of trainees are essential for the success of the programme.

2.6 Internship and Bursary Plan

Internships are organized programmes whereby students gain practical work experience relevant to their field of study. Leeuwpan Coal will provide learning opportunities to youth in the community who are in possession of a diploma and who require the experiential learning for the completion of the diploma.

Bursary plans consist of providing financial assistance to students to pay for study related cost and offering them the opportunity to gain work experience in their field of study during vacation periods. Bursaries are allocated in the following engineering fields namely, mining, metallurgy, geology, engineering (electrical and mechanical), and industrial and in the following support services, namely human resources and environmental studies. Candidates are chosen according to set selection criteria to ensure that they are given the best opportunity to fulfil the university requirements.

Leeuwpan has developed an Internship and Bursary Plan which conforms to the Skills Development Plan, and which focuses on building capacity in various skills and careers for HDSAs. Through offering the opportunity of internships to unemployed graduates, Leeuwpan will increase participants' chances of finding employment in the future.

Workplace diversity and equitable representation at all levels are catalysts for social cohesion, transformation and competitiveness of the mining industry.

3 EFFICIENT AND BENEFICIAL USE OF WATER IN THE PUBLIC INTEREST

In 2012, Ms Susan Shabangu, the then Minister of Mineral Resources of South Africa, in an address at the 2012 South African Coal Export Conference, exclaimed the vital and strategic role played by coal in South Africa's economy. The role played by this industry is supported by the vast resources illustrated in the country's world rankings. According to the Chamber of Mines of South Africa (CMSA), the country is home to 3.5% of the world's coal resources.

The approved IWULs enables the Leeuwpan mining operations to produce coal from the activities which contributes to the abovementioned strategic role that the coal industry plays in South Africa's economy. The licensing of the Witklip Borehole 1 (WK-BH1) and Witklip Borehole 2 (WK-BH2) will allow for mining at Leeuwpan to continue. Furthermore, the public indirectly benefits from coal through fuel and electricity usage. Coal provides 81% of the power generated by state-owned power utility Eskom. In addition, the coal industry benefits the public through being a large employer of workers. According to the CMSA, excluding Sasol, the coal sector employs in the region of 92 230 people, the third largest group in the mining sector after gold and platinum group metals. Their annual earnings are in the region of R139.3 billion.

This highlights the economic contribution, and therefore summarises the economic context within which the industry operates.

The concept of "public interest" is a very complex one. Under the Water Act of 1956, permits were issued to users provided that they use the water beneficially. The use was considered beneficial if the applicant was going to make a profit. Public interest however, goes much wider.

The fact that the applicant has to undertake a public participation process for proposed mining activities, and the public's opinion is to be elicited, means that, at least, the public opinion can be gauged by the response and the comments and concerns received.

As public trustee of the water resources, the Department of Water and Sanitation (DWS) must ensure that the water is protected, used, developed, conserved, managed and controlled in a sustainable and equitable manner for the benefit of all users. The Minister, through the department has to ensure that the water is allocated equitably and used beneficially in the public interest, while promoting environmental values.

A detailed public participation process for the project was undertaken and all the identified impacts were able to be mitigated taking the other water users into consideration.

Leeuwpan recognises that water is a scarce resource which belongs to all people and will strive (through adherence to the conditions and provisions of the IWULs and the IWWMP) to meet the following principles (as stipulated in Section 2 of the NWA) which form the foundation of the NWA:

- Redressing the results of past racial and gender discrimination;
- Promoting the efficient, sustainable and beneficial use of water in the public interest;
- Facilitating social and economic development;
- Protecting aquatic and associated ecosystems and their biological diversity; and
- Reducing and preventing pollution and degradation of water resources.

In addition to the abovementioned, Leeuwpan will adhere to Section 19 of the NWA which stipulates that a water user must take all reasonable measures to prevent any pollution of a water resource from occurring, continuing or recurring. By adhering to the provision, Leeuwpan will ensure that the surrounding water resources are protected and utilised in a beneficial manner.

Water use activities may not commence without an approved water use authorisation. Thus, approval of the water use will indirectly contribute to the beneficial use of water by illustrating that Leeuwpan is committed to adhere to the regulatory regime governing water use in South Africa. Furthermore, Leeuwpan is committed to responsible management of its approved water uses and strives to adhere to the principles of water conservation and demand management which will benefit the community in terms of employment. Monitoring of water resources has been implemented to detect any impacts during the early stages and to mitigate these as soon as practically possible.

As a world-class minerals producer, Exxaro has a moral and legal obligation to ensure responsible and sound environmental management performances. Leeuwpan has an environmental management programme as required under the MPRDA, as well as ISO 14001 accreditation, reflecting global industry standards to minimise environmental impacts.

Exxaro has a Water Management Programme which guides the implementation of best practice water management through-out the organisation. The Water Management Programme focusses on the availability and security of water supply, the efficient and responsible use of scarce resources as well as regulatory compliance. The programme is aligned to best-practice guidelines from the DWS covering integrated water and waste management planning, storm water management planning, water and salt balances and water monitoring systems amongst other issues.

The current water uses are undertaken, managed and controlled in such a way as to ensure that pollution of the water resources is minimised and avoided.

Social and economic development will be facilitated through the employment of local residence and the technical training which these employees receive. Goods and services will be sourced from local businesses as far as possible, to enhance the economic benefits of the project.

During the Water Conservation and Demand Management (WCDM) process at the mining operation, they will deal with Pollution Prevention and also reiterate the key issues relating to impact minimisation, i.e. Water Re-use and Reclamation. It is worthwhile emphasising that consideration and application of water conservation strategies will also often have a direct and significant effect on pollution prevention.

Accordingly, Leeuwpan contributes to the efficient and beneficial use of water by adhering to the regulatory provisions as contained in the IWUL, the provisions of the NWA, best practice standards as well as new best practice technologies.

4 THE SOCIO ECONOMIC IMPACT

4.1 Of the water use or uses if authorised

4.1.1 The Social Impact:

The authorisation of the WK-BH1 and WK-BH2 enables Leeuwpan to continue their initiatives which include, but are not limited to:

- Skills transfer;
- Training initiatives;
- Scholarship opportunities; and
- Other financial contributions made by Leeuwpan.

In addition to the abovementioned, Leeuwpan employs 710 permanent employees and 1145 contractors with employees coming primarily from the local municipality, Delmas area in Mpumalanga and others from other parts of South Africa.

4.1.2 Economic Impact

Leeuwpan's mining operations have a positive impact on the economy, which has lead to increased business sales and increased standards of living in the greater community. Increased employment is associated with increased income and consequently with increased buying power in the area, thus leading to new business sales. The economic benefits mostly include an increase in trade such as local shops, accommodation and transport services.

With the increased employment and a subsequent increase in monthly income, increased business opportunities are experienced within the local environment. The economic benefits that could be generated include an increase in trade, and the development of new trade such as local spaza shops, stalls, etc.

To enhance the positive economic impact of Leeuwpan's operations on the surrounding community, Leeuwpan has an objective of increasing the number of HDSA SMME suppliers through capacity building initiatives which will allow small operators in the local area to become more efficient. At Leeuwpan there are locally owned HDSA companies from which the mine currently procure and if required they will be targeted for a mentorship programme to ensure the sustainability of their business. In addition, Leeuwpan plans to procure additional goods/services that are core to the operations of the mine from other locally owned HDSA companies.

4.2 Of the failure to authorise the water use or uses:

If the mine does not authorise its water uses, the mine will be operating illegally in terms of the NWA. This will have a tremendous impact on the surrounding communities and the mine will be prevented from investing large sums of money that reach an existing community in the forms of income and taxes. The presence of the mine, the employment of local persons and the utilisation of local services will result in an increased income for local communities and businesses and an increased tax base for traditional authorities and municipalities.

The magnitude of the positive economic effect of the Leeuwpan in terms of its contribution to the economy of Nkangala in the form of GDP and employment growth; the strategic importance of this activity in securing much needed foreign exchange for South Africa; for contributing to a sustainable supply of coal to secure generation of electricity and a commitment to ensure no net-loss in agricultural productivity post-mining; creates a compelling case for the continuation of the Leeuwpan Coal Mine. These opportunities will be lost should the project not continue, and will have negative consequences on the local, regional, national and international scale.

5 ANY CATCHMENT MANAGEMENT STRATEGY APPLICABLE TO THE RELEVANT WATER RESOURCE

The DWS, in the spirit of the NWA, recognises the past imbalances relating to water allocation and seeks to regulate water use by enforcing better sharing of water and water related benefits between the whites who have historically been the “high volume water users” and the historically disadvantaged and mostly poor black population.

Catchment Management Agencies (CMAs) are recognised in the NWA as operational institutions to actively support the implementation of integrated catchment (watershed) management policies and strategies at a local level. The agencies are tasked with ensuring that the nation's water resources are protected, used, developed, conserved, managed and controlled in an equitable manner. The CMA is responsible inter alia for: (a) developing and implementing a catchment management strategy that reflects the needs and concerns of all role-players, and (b) coordinating the activities of water users and water. The Olifants River Basin is one of 19 catchment-based water management areas in the country to be managed by a Catchment Management Agency (CMA).

The Olifants River Basin Catchment Management Agency (CMA) is in the process of being established. It will take over direct water resource management responsibilities in the basin currently being performed by DWS. The CMA co-ordinates water-related activities in the basin and provides an effective mechanism for stakeholder participation in water management.

6 THE LIKELY EFFECT OF THE WATER USE TO BE AUTHORISED ON THE WATER RESOURCE AND ON OTHER WATER USERS

6.1 Surface Water

There are four (4) main uses of water that have been identified for the sub catchment of the Bronkhorstspruit up to the receiving water body, namely the Bronkhorstspruit Dam. The surface water uses include the following;

- Domestic use by formal and informal communities along the affected watercourse,
- Irrigation of crops, especially maize,
- Livestock watering including cattle, sheep and poultry and
- Aquatic ecosystems including fish, macro and micro-invertebrates.

Very few water bodies in the Delmas area are used for recreational purposes due to their seasonal nature. In most cases, dams are used for fishing.

No direct abstraction of water from the Bronkhorstspruit occurs for commercial irrigation or extensive domestic use. Dams are usually filled with water from the boreholes and this clean water is mainly used for irrigation. Numerous pans occur in the Delmas area but are not utilized as a source of water for the above mentioned purposes.

6.2 Groundwater

Groundwater is mainly used for domestic supply, small scale irrigation (gardens), livestock watering as well as large scale pivot irrigation of crops. The boreholes used for large scale irrigation exploit the dolomitic aquifer as the yields from the Karoo Supergroup are too low to sustain the high abstraction rates. The groundwater quality in the area is generally good.

Drainage from the opencast backfill will become acidic over the long-term as the ABA results show that the material has the potential to generate acid-mine drainage. The sandstone and soft overburden have limited potential for acidic generation. The shale samples show a great variance in net acidic generation, but may have a potential for acidic generation. Elevation of TDS and SO_4 will occur as a result of pyrite oxidation. In the opencast the SO_4 will increase roughly to about 2 500 mg/l over the long term.

It is not foreseen that significant elevation in metals will occur at near-neutral conditions. After acidification non-compliance for Al, Fe and Mn may occur. Cr, Ni and to a lesser degree As and V are some of the other trace elements that may be slightly elevated and may reach occasional marginal to non-compliance.

The majority of privately owned boreholes are associated with the underlying dolomitic aquifer which in unlikely to be impact by any dewatering activities.

It is likely that preferential flow paths along faults and dolerite intrusion related to fracturing is not significant in the area based on the available data. While it is still anticipated that localised preferential flow zones will exist in relation to dolerite dykes, these zones have not been recorded and it is thought that they are not well developed. As mentioned above the drainage occurs towards the low lying areas such as rivers and streams (Bronkhorstspruit and its tributaries). Some of these streams may be impacted by contaminated seepage and decant.

7 THE CLASS AND THE RESOURCE QUALITY OBJECTIVES OF THE WATER RESOURCE

In South Africa, a river health classification scheme is used to standardise the output of different river systems. The document titled "Resource Directed Measures for Protection of Water Resources: River Ecosystems Version 1.0.24", dated September 1999, compiled by the DWAF, provides the indexes of Attainable Ecological Management Classes (AEMC) as shown in Table 7.1 below. Each index is calibrated so that its results can be expressed in terms of ecological and management perspectives.

Table 7.1 Resource classes as set out by the DWS

River Health Class	Ecological Perspective	Management Perspective
Natural / Excellent (Class A)	No or negligible modification of in-stream and riparian habitats and biota	Protected rovers; relatively untouched by human hands; no discharges or impoundments allowed
Good (Class B)	Ecosystems essentially in good state; biodiversity largely intact	Some human-related disturbance but mostly of low impact potential
Fair (Class C)	A few sensitive species may be lost; lower abundances of biological populations are likely to occur, or sometimes, higher abundances of tolerant or opportunistic species occur	Multiple disturbances associated with need for socio-economic development, e.g. impoundment, habitat modification and water quality degradation
Poor (Class D)	Habitat diversity and availability have declined; mostly only tolerant species present; species present are often diseased; population dynamics have been disrupted (e.g. biota can no longer reproduce or alien species have invaded the ecosystem)	Often characterised by high human densities or extensive resource exploitation. Management intervention is needed to improve river health – e.g. to restore flow patterns, river habitats or water quality

According to the "Classes and Resource Quality Objectives of Water Resources for The Olifants Catchment" published on the 22nd of April 2016 in the Government Gazette No.39943, Regulation 466, the Bronkhorstspruit river catchment falls into the Ecological Management Class C as defined in Table 7.2.

Table 7.2 Resource classes for the Bronkhorstspruit

River Name	Integrated Unit of Analysis (IUA)	Water Resource Class for IUA	Biophysical Node Name	Quaternary Catchment	Ecological Category to be maintained
Bronkhorstspruit (outlet of quaternary)	2 Wilge River catchment area	II	HN21/RU21	B20A	C

7.1 Receiving water quality objectives and the reserve

Constant increases in water demands, particularly from the Olifants River, motivated the DWS to investigate the water requirements of users in terms of both water quantity and quality, as well as the current management of the water resource. According to the "Classes and Resource Quality Objectives of Water Resources for The Olifants Catchment" published on the 22nd of April 2016 in the Government Gazette No.39943, Regulation 466, no Resource Water Quality Objectives (RWQOs) have been set for the Bronkhorstspruit.

RWQOs have however been set for the Wilge River, of which the Bronkhorstspruit merges downstream. The RWQOs for the Wilgre River at the outlet of the identified IUA (in quaternary catchment B20J) are presented in Table 7.3.

Table 7.3 System variables (DWA 2001)

Sulphates	<200mg/L
F	≤ 2.50 mg/L
Al	≤ 0.105mg/L
Pb hard	≤ 9.5 µg/L
As	≤ 0.095mg/L
Se	≤ 0.022mg/L
Cd hard	≤ 3.0 µg/L
Cr(VI)	≤ 121 µg/L
Cu hard	≤ 6.0 µg/L
Hg	≤ 0.97 µg/L
Mn	≤ 0.990mg/L
Zn	≤ 25.2 µg/L
Chlorine	≤3 dissolve.1 µg/L free Cl
Endosulfan	≤ 0.13 µg/L
Atrazine	≤ 78.5 µg/

8 INVESTMENTS ALREADY MADE AND TO BE MADE BY THE WATER USER IN RESPECT TO THE WATER USE IN QUESTION

Substantial investments, time and various authorisation have been undertaken for the various authorisations of Leeuwpan's coal mining activities. The Leeuwpan Mining Operations is a coal mining operation seeking to optimise its operations, increase productivity while achieving environmental and social goals and objectives.

Leeuwpan's current investments and future investments relates to the continuous maintenance and upkeep of the current closed water systems which includes the operation of all water pipelines on the mine, and the maintenance of all trenches and channels, and Dams that is part of the clean and dirty water systems. Leeuwpan will not intentionally discharge water into the environment as the mine works on a closed water system.

9 THE STRATEGIC IMPORTANCE OF THE WATER USES TO BE AUTHORISED

In strict economic terms, the overall mining industry is paramount to South Africa's current and future prosperity. The primary value chain alone accounts for approximately 500 000 jobs directly and indirectly creates further employment opportunities and jobs that contribute to the economy. As per the CMSA's Integrated Annual Review for 2019, the mining sector contributed R360.9 billion to GDP (8.1%), R24.3 billion to taxes and employed 454 861 people.

Numerous Mining Companies are further listed on the Johannesburg Stock Exchange (JSE), which therefore helps create wealth for millions of South African pension fund holders and investors, while at the same time attracting significant foreign capital flows that help unlock our mineral potential. And, perhaps most critically, more than half of our export earnings are derived from mining and mineral products.

With specific reference to coal mining, total sales for coal in 2019 reached R139.3 billion with an overall production of 258.9Mt. The coal industry employed 92 230 people directly who collectively earned R27.9 billion.

The mining industry is of strategic importance to South Africa and thus awarding the water use licence will enable Leeuwpan to continue mining and to actively participate as an essential element of South Africa's economy. As previously stated, Leeuwpan directly contributes to the South African economy by means of the following:

- Promoting BEE;
- Creating jobs;
- Developing its people, and in so doing contributing to the transformation of the industry's leadership and skills base; and
- By having a positive impact on the local communities through economic development and sustainable social initiatives.

10 THE QUALITY OF WATER IN THE WATER RESOURCE WHICH MAY BE REQUIRED FOR THE RESERVE AND FOR MEETING INTERNATIONAL AGREEMENTS

10.1 International Agreements

International negotiations and institutional arrangements are handled at National Level. From a WMA management perspective, it will be required to communicate all issues relating to the international agreements through the appropriate channels at National Level.

The Olifants WMA falls within the Limpopo River Basin, which is shared by South Africa, Botswana, Zimbabwe and Mozambique. As the Olifants River flows directly from South Africa into Mozambique, where it joins the Limpopo River, developments in South Africa directly impact upon Mozambique.

Discussions have been held between Mozambique and South Africa as far back as 1971 with the development of the Massingir Agreement of 1971. This agreement dealt specifically with the building of the Massingir Dam. The principles of the Helsinki Rules were used prior to 2000 to guide the relations between South Africa and neighbouring states. In 1995, the SADC countries established the 1995 Protocol dealing with Shared Watercourse Systems. The 1995 Protocol was repealed in September 2003 and replaced with the 2000 Protocol which is now used to guide management and development on Shared Watercourse Systems.

Joint utilization of the water resources of the Olifants River is facilitated through the bilateral Joint Water Commission between South Africa and Mozambique. International co-operation with respect to the use and management of the watercourses in the Limpopo River Basin, was overseen by the Limpopo Basin Permanent Technical Committee (LBPTC) with membership by South Africa, Botswana, Zimbabwe and Mozambique. The LBPTC was replaced by the Limpopo Water Course Commission, established in November 2003 (*Olifant ISP*).

10.2 Surface Water Quality

The surface water quality results were obtained from the Monthly Water Quality Report conducted by Environmental Assurance (Envass) in October 2020 (Annexure B of the IWWMP Report).

10.2.1 Receiving Environmental Water Quality

Surface water monitoring was performed at ten (10) monitoring localities during the monitoring period. The following samples were recorded as dry during the site assessment: LSW06, LSW07, LSW08, LSW12, WP01 and RD1.

The majority of the sampled receiving environment monitoring localities water quality analysis indicated exceedances in terms of the DWAF Domestic Guideline Limits for Turbidity, Calcium and Dissolved Organic Carbon (DOCmg/l). Additional exceedances included the Calcium (Ca), Magnesium (Mg), Sulphate (SO_4), Manganese (Mn) and *E.coli*.

From the October 2020 results it is evident that the majority of the receiving environment monitoring localities presented overall fair condition. Turbidity within the surface water samples are expected, as turbidity refers to the measurement of the cloudiness or muddiness of water, which is influenced by both natural (flow velocity, rainfall, run-off etc.) and anthropogenic activities (disturbance/mining activities). Overall, the Total Inorganic Nitrogen (TIN), Nitrate (NO_3-N) and the Ammonia (NH_3-N) levels remained low, with the majority (excluding LSW13) of the concentrations recording below the detection limit.

Duplicate samples were obtained from monitoring localities LSW03, LSW05 and WP02 in order to determine the accuracy and precision of inter-laboratory results. Comparison of the calculated TDS and computation of relative percent difference for the duplicate pairs were calculated between a range of 0.0 to 3.65% for the October 2020 monitoring run, recording within the acceptable range (30%).

10.2.2 Process Water Quality

Process water monitoring was performed at sixteen (16) monitoring localities during the monitoring period. The following samples could not be obtained during the monitoring run: KR03, KR04, OG PIT, OH PIT, OJ PIT, OM PIT, WLV PIT and OWM-PIT. Refer to the sampling register as presented in Appendix A of Annexure B for details.

All of the monitored process localities revealed compliance to the stipulated WUL limits. The October 2020 exceedances can be summarised as follows:

- **KR01A , LSW09 and WP04:**
    - General Authorisation Limit: Electrical Conductivity (EC) and Manganese (Mn).
- **ODN PIT:**
    - General Authorisation Limit: Electrical Conductivity (EC) and Manganese (Mn) WUL Limit: *E.coli*.

Discharge of the process water into the receiving environment is prohibited according to the General Authorisation (Section 21f and h, 2013) as it could have limiting effects on the receiving water environment. Note that regular maintenance on process water facilities linings and transfer pipes are vital for water resource protection.

10.2.3 Effluent Water Quality

Final effluent samples are collected at two (2) monitoring localities inclusive of the Septic tanks at plant and the Final effluent from the sewage plant.

The final effluent from LWP-SP-P historically recorded non-compliant to the set Ammonia Wastewater WUL limits, while exceedances related to the General Authorisation limits included Suspended Solids, Ammonia and Chemical Oxygen Demand.

During the monitoring period it was noted that the LWP-SP-P was not active and no access was obtained to the LWP-SP-W monitoring point.

10.2.4 Potable Water Quality

Four (4) potable water localities form part of the monitoring programme at Exxaro Leeuwpan Mine. **It should be noted that the water is not used as a potable source, however monitored as such in case of accidental consumption as a precautionary measurement**. During the monitoring period a sample could not be obtained from PIET-SCHUTTE as water was not pumping.

The potable water quality at Leeuwpan can generally (historical results) be described as neutral, non-saline and hard while elevated salinity and Total Hardness was present from Load-Out Bay Offices (LLBDW) and Drinking Water at Laboratory (LWDL) during October 2020. The Load-Out Bay Offices (LLBDW) revealed exceedances of Electrical Conductivity (EC), Total Dissolved Solids (TDS), Sulphate (SO_4), Turbidity, Heterotrophic Plate Counts and E.coli which renders the water as not suitable for potable purposes. The Drinking Water Supply Tank (LDWST) presented an exceedance of Heterotrophic Plate Counts, while the remainder of the parameters presented ideal water quality. The Drinking Water at Laboratory (LWDL) presented an exceedance of Electrical Conductivity (EC), Total Dissolved Solids (TDS), Sulphate (SO4) and Heterotrophic Plate Counts.

Based on the historical analysed parameters and data, the potable water poses a risk for infection due to the elevated Heterotrophic Plate Counts and thus it is strongly advised that the water be treated and filters regularly disinfected and cleaned as the high counts may be attributed to biofilms.

10.2.5 Conclusion and Aspects to Consider

The scope of work performed at the Leeuwpan Coal Mine is as per WUL requirements as listed in this report. This report aims to highlight the conditions requirements of the WUL as well as aspects that are to be considered in order to improve compliance of the IWUL.

During the monitoring period samples LSW06, LSW07, LSW08, LSW12, WP01, RD1, KR03, KR04, OG PIT, OH PIT, OJ PIT, OM PIT, WLV PIT, LWP-SP-W, OWM-PIT and PIET-SCHUTTE could not be obtained during the monitoring period.

Based on the historical analysed parameters and data, the potable water poses a risk for infection due to the elevated Heterotrophic Plate Counts as well as health risks. It is strongly advised that the water not be used for potable or domestic purposes and "no-drinking signs" be present as current implemented.

Exceedances of Ca, Mg, Turbidity, Dissolved Organic Carbon (DOC) and indicated presence of Oil and Grease were presented at the receiving environment. From the results it is evident that the majority of the receiving environment monitoring localities presented overall fair condition with general low salinity content.

The process water samples revealed compliance to the stipulated WUL limits, except for the ODN-PIT monitoring point which exceeded the limit for E.coli. Discharge of the process water into the receiving environment is prohibited according to the General Authorisation (Section 21f and h, 2013) as it could have limiting effects on the receiving water environment. Note that regular maintenance on process water facilities linings and transfer pipes are vital for water resource protection.

Representative samples related to October 2020 could not be obtained thus the final effluent from LWP-SP-P historically recorded non-compliant to the set Ammonia Wastewater WUL limits, while exceedances related to the General Authorisation limits included Suspended Solids, Ammonia and Chemical Oxygen Demand.

During the monthly monitoring period, the majority of the localities presented relatively stable conditions compared to September 2020, with fluctuation in bacteriological content noted.

Aspects to consider:

- The potable water poses a risk for infection based on the elevated bacteriological and thus it is strongly advised that the water be treated and filters regularly disinfected and cleaned as the high counts may be attributed to biofilms, however warning signs have been implemented indicating water is unfit for human consumption;
- Clean and dirty stormwater must be separated as reasonably possible;
- All waste water be contained and not released into the receiving environment;
- All spills and incidents be reported to the SHEQ manager; and

- Immediate reporting of any polluting or potentially polluting incidents be implemented.

10.3 Groundwater Quality

The groundwater quality results were obtained from the Quarterly Water Quality Report conducted by Environmental Assurance (Envass) in September 2020 (Annexure C of the IWWMP Report).

Groundwater monitoring was performed during September 2020 and twenty-two (22) borehole samples were obtained across the site.

Groundwater level depths typically vary between 1 and 54 meters below surface with the historical deepest level measured in monitoring borehole MOAMB9. The groundwater levels form boreholes MOAMB4 and RKL02 presents a water divide flowing towards the Bronkhorstspruit and the Bronkhorstspruit tributary.

The majority of the sampled localities recorded concentrations within the stipulated SANS 241-1:2015 limits presenting satisfactory conditions which included the following monitoring localities: WWN01, WELMB13S, RKL04, MOAMB4, MOAMB9, MOAMB10, WITMB14, WOLMB15S, LEEMB18S, WTN-02S and WTN01D. The remaining monitoring localities presented SANS 241-1:2015 exceedances summarised as follows:

- WELMB13D:
    - Sulphate (SO_4) and Manganese (Mn);
- LW07:
    - Fluoride (F), Iron (Fe), Manganese (Mn) and Ammonia (N);
- RKL01, LWG02:
    - Manganese (Mn);
- RKL02:
    - Ammonia (N);
- KENMB2S, KENMB3D, WOLMB15D, LEEMB18D:
    - Electrical Conductivity (EC), Total Dissolved Solids (TDS) and Sulphate (SO_4);
- MOAMB7:
    - Aluminium (Al); and
- WTN01S:
    - Sulphate (SO4) and Manganese (Mn);

According to the Expanded Durov Diagram (Figure 10.1) and associated Stiff Diagram (Figure 10.2); the September 2020 reveals that the majority of the aforementioned boreholes are

dominated by calcium cations and sulphate anions. Based on the recorded results it is evident that impacts on the boreholes are present which is related to the mining operation.

According to Expanded Durov Diagram (Figure 10.1) and associated Stiff Diagram (Figure 10.2), the aquifer regime within the vicinity of the Exxaro Leeuwpan Mine is dominated by the following types of groundwater:

- Field 2: Fresh, clean, relatively young groundwater that has started to undergo Magnesium ion exchange, often found in dolomitic terrain.
- Field 4: Fresh, recently recharged groundwater with HCO_3 and CO_3 dominated ions that has been in contact with a source of SO_4 contamination or that has moved through SO_4 enriched bedrock.
- Field 5: Groundwater that is usually a mix of different types – either clean water from fields 1 and 2 that has undergone SO_4 and NaCl mixing/contamination or old stagnant NaCl dominated water that has mixed with clean water.

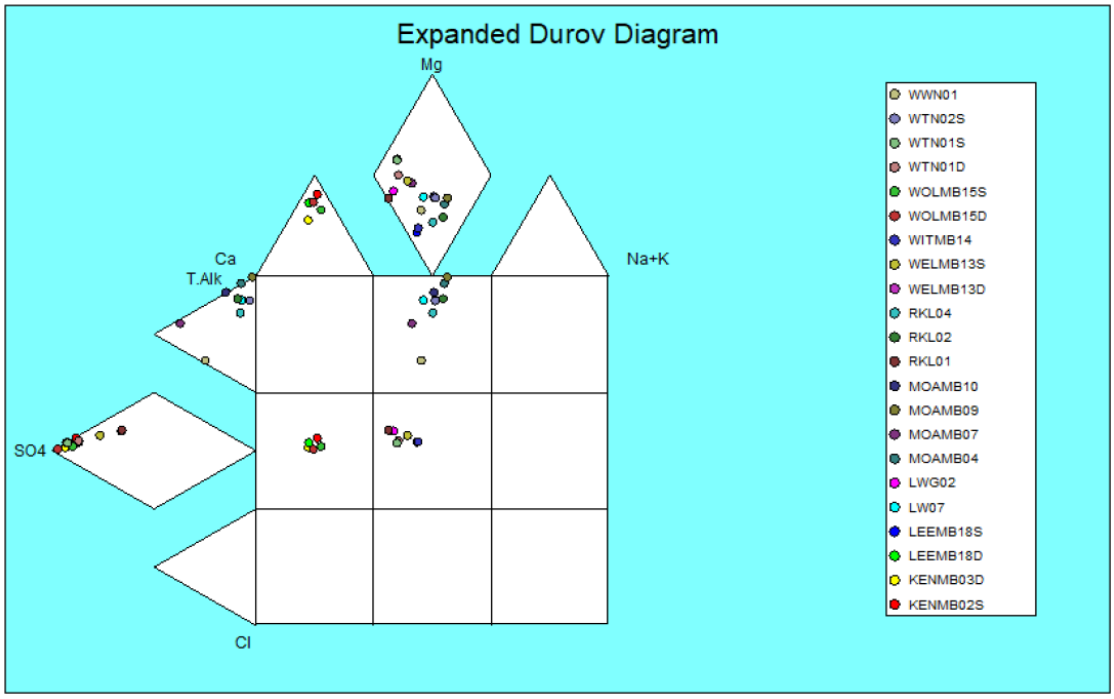


Figure 10.1 Expanded Durov diagram of groundwater chemistry regarding March 2020 (Envass, 2020)

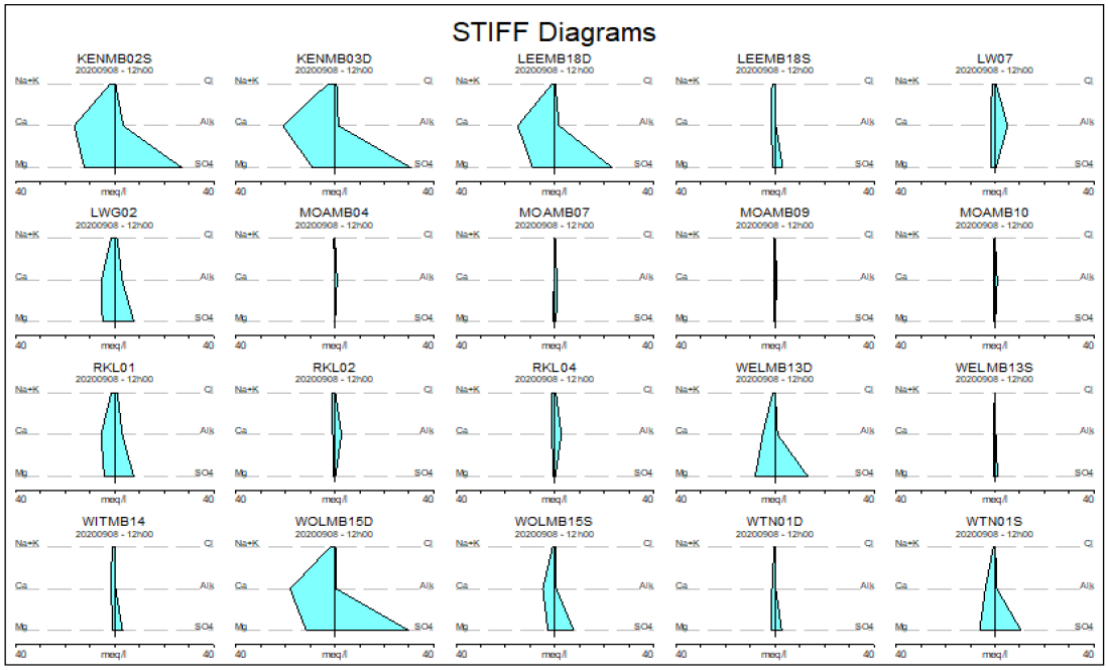


Figure 10.2 Stiff diagrams of groundwater chemistry regarding September 2020 (Envass, 2020)

11 THE PROBABLE DURATION OF ANY UNDERTAKING OR WHICH A WATER USE IS TO BE AUTHORISED

The water uses being applied for will continue until the current life of mine (2030).

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Annexure B
Hydrogeological Assessment



63 Wessel Road, Rivonia, 2128 PO Box 2597, Rivonia, 2128 South Africa
Tel: +27 (0) 11 803 5726 **Fax:** +27 (0) 11 803 5745 **Web:** www.gcs-sa.biz

Exxaro Leeuwpan Coal Mine
Section 21 (a)
Water Use License Application (WULA)

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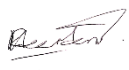
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Author	Rudolf Van Heerden		02 April 2020
Unit Manager	Kobus Troskie		02 April 2020
Director	Alkie Marais		02 April 2020

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CONTENTS PAGE

1 INTRODUCTION 5
2 SCOPE OF WORK 5
3 METHODOLOGY 5
3.1 DESKTOP STUDY 5
3.2 HYDROCENSUS 6
3.3 AQUIFER TESTING 6
3.4 GROUNDWATER SAMPLING 6
3.5 GROUNDWATER RESERVE DETERMINATION 7
4 SITE INFORMATION 8
4.1 LOCALITY 8
4.2 TOPOGRAPHY AND HYDROLOGY 8
4.3 GEOLOGICAL AND HYDROGEOLOGICAL SETTING 8
5 FIELD INVESTIGATION 11
5.1 HYDROCENSUS 11
5.2 AQUIFER TESTING 11
5.2.1 Recommended pumping schedule 12
6 LABOROTORY ANALYSIS 15
6.1.1 General Parameters 16
6.1.2 Anions 16
6.1.3 Cations and Metals 16
6.2 PIPER DIAGRAM 16
7 GROUNDWATER RESERVE DETERMINATION 18
7.1 QUATERNARY CATCHMENT 18
7.2 SUB-CATCHMENT DELINEATION 18
7.2.1 Registered Abstraction 19
7.2.2 Theoretical Groundwater Balance 21
7.2.3 Theoretical Water Quantity 22
8 IMPACT ASSESSMENT 25
8.1 IMPACT ASSESSMENT 27
8.1.1 Operational Phase 27
8.1.2 Mitigation Plan 29
8.1.3 Groundwater monitoring plan 29
9 CONCLUSION 30
10 REFERENCES 31

LIST OF FIGURES

Figure 4-1: Locality Map 9
Figure 4-2: Geology Map 10
Figure 5-1: Site Layout Map 13
Figure 5-2: Aquifer Test Results for Borehole WK-BH1 14
Figure 6-1: Piper Diagram for Sample WK-BH1 17
Figure 7-1: Delineated Sub-catchment with WARMS Boreholes shown on map 24

LIST OF TABLES

Table 5-1: Aquifer Test Borehole Details for Borehole WK-BH1 11
Table 5-2: Aquifer Test Results for Borehole WK-BH1 12
Table 5-3: Recommended Pumping Schedule for WK-BH1 12
Table 6-1: Groundwater Laboratory Results 15
Table 7-1: Quaternary Catchment Details for Catchment B20A 18
Table 7-2: WARMS Borehole Details for Quaternary Catchment B20A 19
Table 7-3: Theoretical Groundwater Balance Calculation for Delineated Sub-catchment Containing the Site 22
Table 7-4: Guide for determining the level of stress of a groundwater resource unit 23
Table 8-1: Severity 25
Table 8-2: Spatial Scale - How big is the area that the aspect is impacting on? 25
Table 8-3: Duration 26
Table 8-4: Frequency of the activity - How often do you do the specific activity? 26
Table 8-5: Frequency of the incident/impact - How often does the activity impact the environment? 26
Table 8-6: Legal issues - How is the activity governed by legislation? 26
Table 8-7: Detection - How quickly/easily can the impacts/risks of the activity be detected on the environment, people and property? 26
Table 8-8: Impact Ratings 26
Table 8-9: Impact Assessment Results 28
Table 8-10: Water Level Monitoring Plan for WK-BH1 29
Table 8-11: Hydro chemical Sampling Plan for WK-BH1 30

LIST OF APPENDICES

APPENDIX A: LABORATORY CERTIFICATE 33
APPENDIX B: AQUIFER TEST RESULTS 38
APPENDIX C: GROUNDWATER MODEL REPORT (GCS, 2019) 41

1 INTRODUCTION

GCS Water and Environmental (Pty) Ltd was contracted by Exxaro Leeuwpan Coal Mine to conduct a hydrogeological investigation as per proposal by GCS dated 24 October 2019. The document will be submitted as supporting documents for a Water Use Licence Application (WULA).

2 SCOPE OF WORK

Following work was accepted as the scope of work:

- Detailed desktop study;
- Hydrocensus/neighbouring land survey within a 1km radius of the sub-catchment containing the abstraction borehole;
- Identify any sensitive areas (e.g. wetlands, streams etc.) within a 500m radius of the site;
- Aquifer testing;
- Groundwater sampling;
- Groundwater reserve determination;
- Compilation of a detailed hydrogeological report with the findings of the investigation as well as detailed recommendations for resource development, management and monitoring and relevant information for inclusion within the WULA.

3 METHODOLOGY

3.1 Desktop study

GCS assessed all available geological and hydrogeological data prior to the commencement of any fieldwork. All existing groundwater data was reviewed and assessed during the desktop study.

The following data sources were used during the study:

- Topographic 1:50 000 maps;
- Geological 1:250 000 map;
- Hydrogeological 1:500 000 map;
- Groundwater Resource Directed Measures (GRDM, 2013) obtained from the Department of Water and Sanitation (DWS);

- Existing hydrogeological reports for the site or in the area.

3.2 Hydrocensus

A hydrocensus was conducted within the sub-catchment containing the site, within all accessible areas. The following information was recorded during the hydrocensus:

- GPS co-ordinates and elevation of existing boreholes or springs;
- Water levels of the boreholes, where accessible;
- Estimated abstraction volumes, where provided;
- Any other information regarding the water reliability or quality;
- Identifying surface water bodies and usage;
- Determine groundwater usage and identify groundwater users.

3.3 Aquifer testing

The borehole was pumped for 24 hours at a constant rate. The water level within the borehole was monitored during the pumping. This data was used to determine the aquifer characteristics, such as transmissivity and storage.

After pumping the water level within the borehole was monitored to determine the recovery of the water level with time. This allows for the evaluation of dewatering and pumping schedules. The aquifer test data was analysed to determine the following:

- Sustainable yield;
- Abstraction schedule;
- Pump inlet depth; and
- Management.

3.4 Groundwater Sampling

A groundwater sample was collected from the existing production borehole to determine the preliminary groundwater condition. The methodology in the collection and preservation of groundwater samples are important for the reliability of the analysis.

The samples were submitted to an accredited laboratory services for analysis and included the following analyses:

- Metals: Ca, Mg, Na, K, Fe, Al, Mn and B.
- pH, Electrical conductivity, Alkalinity,
- Nitrate and nitrite, Chloride, Sulphate and Fluoride.

3.5 Groundwater Reserve Determination

A groundwater balance was prepared for the sub-catchment. This took into account all resource input and outputs. It accounted for the rainfall recharge, existing abstraction and basic human needs. This was used to determine how much groundwater is available for abstraction.

3.6 Groundwater Impact Assessment

An impact assessment was conducted based on the available data obtained during the previous phases of work. In order to identify areas of concern the following needs to be determined:

- Area of shallow groundwater levels;
- Potential groundwater quality impacts.

4 SITE INFORMATION

4.1 Locality

The site is located at is located south east of Delmas, in the Victor Khanye Local Municipality, Mpumalanga. The locality map is shown in Figure 4-1.

4.2 Topography and Hydrology

From the 1:50 000 Topographical Map and observations on site, the site gently slopes in a South-easterly direction. The area surrounding the mine mainly used for agricultural purposes. The project area is located within the B20A quaternary catchment (refer to Table 7-1) of the Olifants water management area (WMA). The main Hydrogeological feature draining the area is the Bronkhorstspruit river draining the area to the east of the mine with one non-perennial tributary joining the Bronkhorstspruit river to the north of the site.

4.3 Geological and Hydrogeological Setting

According to the 1:250 000 Geological map 2628 East Rand, the site is underlain by sandstone shale and coal beds of the Vryheid Formation (also refer to the geology map in Figure 4-2). The Vryheid formation originates form the Ecca Group formed in the Permian Era. During this time large part of Southern Africa was charecterised by shallow marine and swamp environments. It was during this time that the Dwyka and Ecca Groups were deposited, the two main subdivisions of the Karoo Supergroup. The carbonaceous shale would be formed in the swamp environments below the water level with the coal formed from the compacted plant matter deposited in the bottom of the peat swamps (Ryan and Whitfield, 1978). The dolerite (Jd) intruded into the surrounding sedimentary strata in the Jurassic Era.

According to the 1:500 000 Hydrogeological map series 2526 Johannesburg (Moseki et al, 2003) the igneous mafic and ultramafic rocks represent intergranular and fracted aquifer types with a moderately-yielding (0.5 – 2.0 L/s) aquifer system of variable water quality. Groundwater would most likely occur on the joints and fractures along the intrusions and as a result of heating and cooling of the surrounding country rocks by the magmatic intrusions.

FIGURE 4-1: LOCALITY MAP



LEGEND

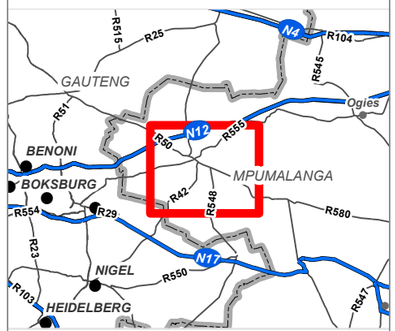
- Towns
- Site Location

Rivers and Streams

- Non-Perennial
- Perennial

Road Network

- National Route
- Main Road
- Secondary Road
- Street



Data Sources:
Esri Basemap 2020
Data supplied from Specialist (R Van Heerden)

0 1 2 Kilometers

SCALE: 1:80 000

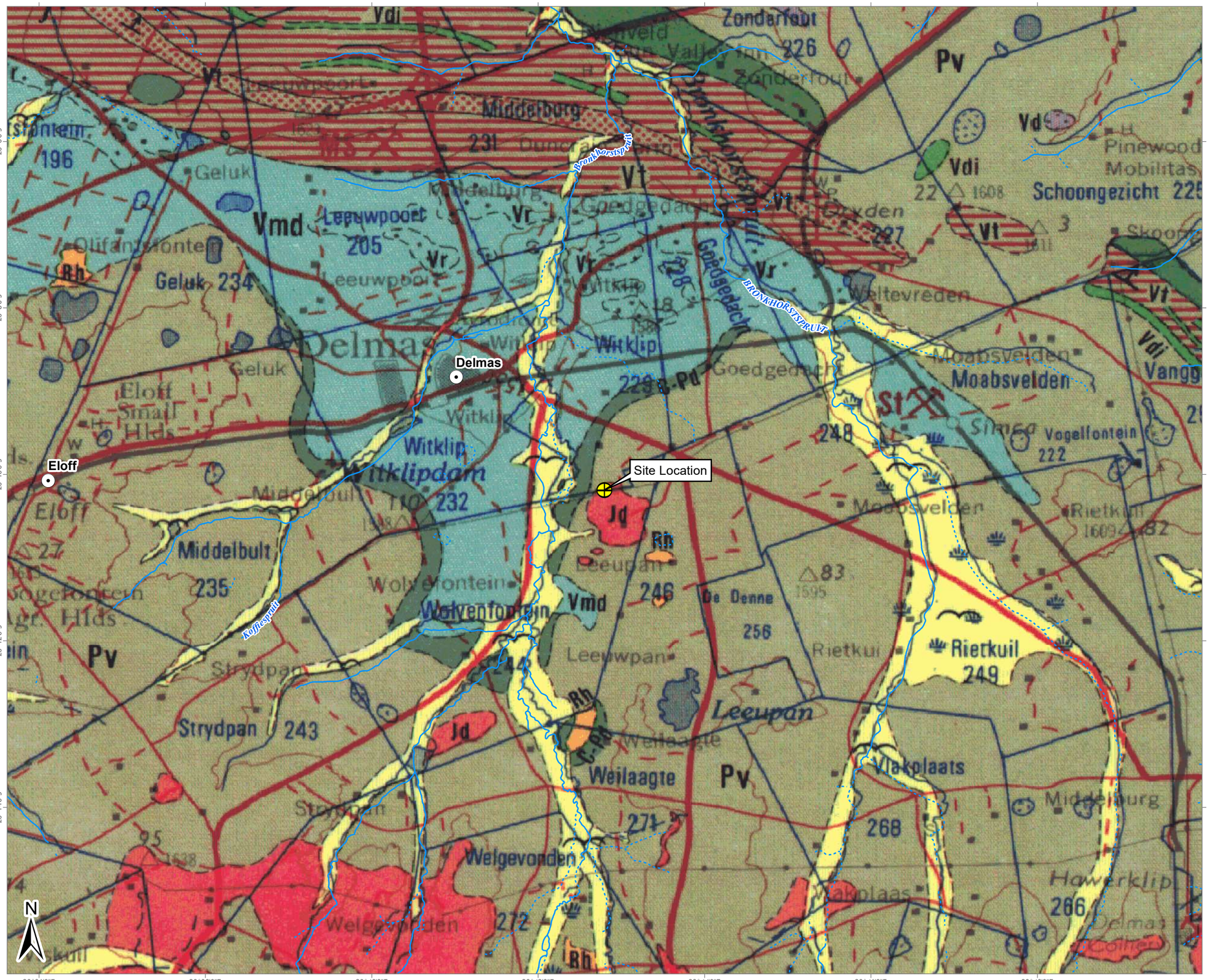
FIGURE NO.:	4-1	MAP NUMBER:	19-0902-01
DRAWN BY:	N NAIDOO GIS CONSULTANT	REVIEWED BY:	C BOTHA GIS SPECIALIST
DATUM: PROJECTION:	WGS84 GEOGRAPHIC	DATE:	14 JANUARY 2020
PROJECT: CLIENT:	LEEUWPAN SECTION 21(A) WULA EXXARO		

GCS Water & Environmental Consultants

63 Wessel Road Woodmead
PO Box 2597 Rivonia 2128
South Africa

Tel: +27 (0) 11 803 5726
Fax: +27 (0) 11 803 5745
E-mail: jhb@gcs-sa.biz
www.gcs-sa.biz

FIGURE 4-2: GEOLOGY MAP



LEGEND

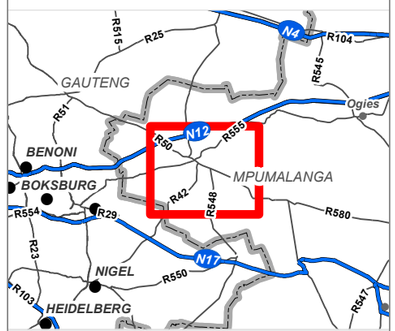
- Towns
- Site Location

Rivers and Streams

- Non-Perennial
- Perennial

Lithology

- Alluvium
- Jd — Dolerite
- Pv — Sandstone, shale, coal beds
- C-Pd — Diamictite, shale
- Vdi — Diabase
- Vd — Quartzite, shale
- Vt — Ferruginous shale
- Vt — Ferruginous quartzite
- Vr / Vmd — Vmd - dolomite, chert; Vr - chert breccia, conglomerate
- Rh — Shale (partly ferruginous), quarzite, banded ironstone (contorted bed)



Data Sources:
Council for Geoscience
1:250 000 Geological Series: 2628

0 1 2 Kilometers

SCALE: 1:80 000

FIGURE NO.:	4-2	MAP NUMBER:	19-0902-03
DRAWN BY:	N NAIDOO GIS CONSULTANT	REVIEWED BY:	C BOTHA GIS SPECIALIST
DATUM: PROJECTION:	WGS84 GEOGRAPHIC	DATE:	14 JANUARY 2020
PROJECT: CLIENT:	LEEUWPAN SECTION 21(A) WULA EXXARO		

GCS Water & Environmental Consultants
63 Wessel Road Woodmead
PO Box 2597 Rivonia 2128
South Africa
Tel: +27 (0) 11 803 5726
Fax: +27 (0) 11 803 5745
E-mail: jhb@gcs-sa.biz
www.gcs-sa.biz

5 FIELD INVESTIGATION

5.1 Hydrocensus

The hydrocensus was carried out by GCS around the site on the 28th of November 2019. No other production boreholes could be found abstracting groundwater from the aquifer system in a 1 km radius surrounding the site, or within the sub-catchment containing the site. A number of monitoring wells are located within the vicinity of the mine.

5.2 Aquifer Testing

A Constant Rate (CR) and Recovery Test (RT) were conducted on the production borehole WK-BH1 on site. A CR test is a field experiment in which a well is pumped at a controlled rate and water-level response (drawdown) is measured. The response data from the pumping test was used to estimate the hydraulic properties of the aquifer. The borehole had a static water level of 26.5 mbgl. The pump inlet depth was not possible to determine with existing downhole equipment installed at the time of the site visit. The borehole details are presented in Table 5-1.

Table 5-1: Aquifer Test Borehole Details for Borehole WK-BH1

BH ID	Coordinates		Static Water Level	Pump Inlet Depth	Borehole Depth	Test Duration
	Latitude	Longitude				
[-]	[DD]	[DD]	[mbgl]	[mbgl]	[mbgl]	[hrs:min]
WK-BH1	-26.17330	28.71013	28.00	-	78	24:00

Note/s:

- [-] - not applicable
- [BH ID] - borehole identification
- [N/A] - not applicable
- [mbgl] - decimal degrees
- [m] - metres
- [hrs:min] - hours : minutes

The aquifer test results are presented in Figure 5-2 and the details are summarized in Table 5-2. The borehole WR-BH1 was pumped at a constant rate of 20 L/s for 24 hours and a total drawdown of 11.42 was achieved. The borehole recovered to 90% of the original water level within 1 hour and 30 minutes with a total recovery of 100% reached after 3 hours and 30 minutes.

The aquifer test data was analysed with using FC_EXCEL method and Wish 3.02.192c software. The FC_EXCEL software was developed by the Institute for Groundwater Studies, University of the Free State (Van Tonder *et al.* 2001). The Cooper Jacob straight line method was used to determine the transmissivity based on the drawdown data. The transmissivity is defined as the measure of the ease with which water will pass through the earth's material; expressed as the product of the average hydraulic conductivity and thickness of the saturated portion of an aquifer. It therefore indicates the ease with which water moves through the subsurface and is used to calculate rates of groundwater movement. The test results computed a transmissivity (T-value) of 13.9 m^2/day for the fracture network and can be seen in Table 5-2 and Appendix B.

Table 5-2: Aquifer Test Results for Borehole WK-BH1

BH ID	Total Recovery Duration	90% Recovery	Recovery	Total Drawdown	Pump Yield	Transmissivity
[-]	[hrs:min]	[%]	[%]	[m]	[l/s]	[m2/day]
WK-BH1	08:00	01:30	100	11.42	20.00	

Note/s:

- [-] - not applicable
- [hrs:min] - hours : minutes
- [BH ID] - borehole identification
- [%] - Percentage
- [l/s] - litres / second
- [m2/day] - square meters per day

5.2.1 Recommended pumping schedule

Based on the aquifer test data the recommended pumping schedule can be seen summarized in Table 5-3. The borehole can be pumped at a yield of 20 L/s for 20 hours and left to recover for 4 hours once pumping has stopped. Given this abstraction schedule a total volume of 1 440 m^3 /day can be abstracted from the borehole. The pump inlet depth should be at 75 mbgl if possible.

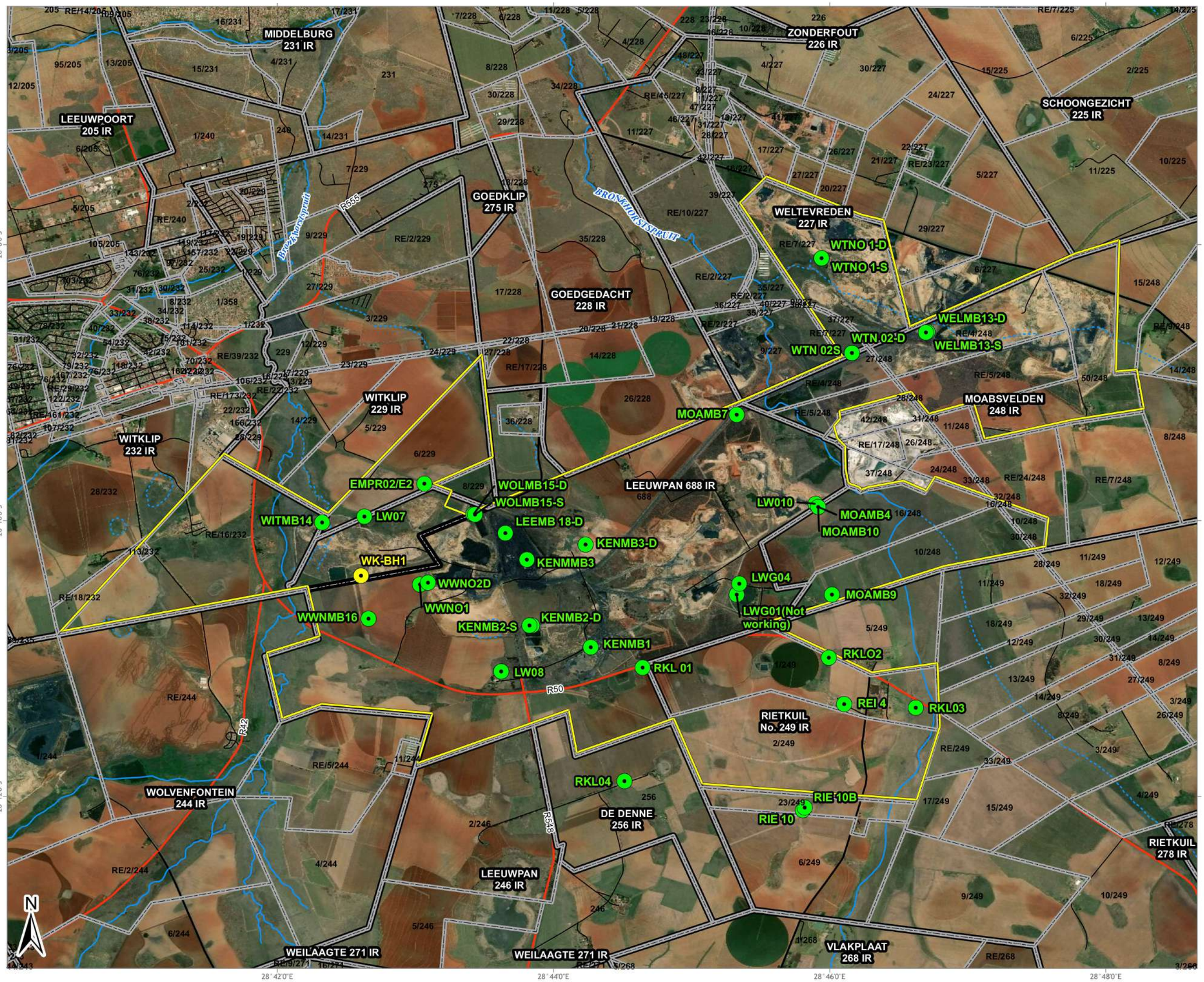
Table 5-3: Recommended Pumping Schedule for WK-BH1

BH ID	Pump Depth	Pump Cycle	Recovery Time	Recommended Yield		
[-]	[mbgl]	[hrs]	[hrs]	[l/s]	[l/hr]	[l/d]
WK-BH1	75	20	4	20.00	72 000	1 440 000

Note/s:

[-]	-	not applicable
[mbgl]	-	meters below ground level
[hrs]	-	hours
[l/s]	-	liters / second
[l/hr]	-	liters / hour
[l/d]	-	liters / day

FIGURE 5-1: SITE LAYOUT MAP



LEGEND

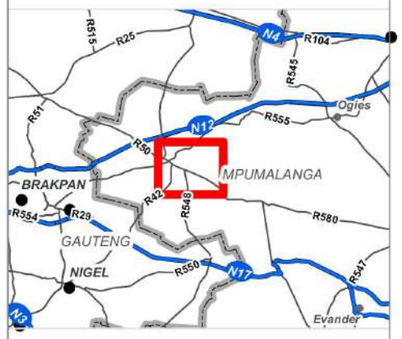
- Production Borehole
- Monitoring Borehole
- Mining Right Boundary

Rivers and Streams

- Non-Perennial
- Perennial

Road Network

- Main Road
- Secondary Road
- Street
- Parent Farm
- Farm Portion



Data Sources:
Esri Basemap 2020
Data supplied from Specialist (R Van Heerden)
DRDLR Cadastral Data v1.3, 01 June 2018

0 1 2 Kilometers

SCALE: 1:48 000

FIGURE NO.:	-	MAP NUMBER:	19-0902-05
DRAWN BY:	N NAIDOO GIS CONSULTANT	REVIEWED BY:	C BOTHA GIS SPECIALIST
DATUM: PROJECTION:	WGS84 GEOGRAPHIC	DATE:	17 JANUARY 2020
PROJECT:	LEEUWPAN SECTION 21(A) WULA		
CLIENT:	EXXARO		

GCS Water & Environmental Consultants
63 Wessel Road Woodmead
PO Box 2597 Rivonia 2128
South Africa
Tel: +27 (0) 11 803 5726
Fax: +27 (0) 11 803 5745
E-mail: jhb@gcs-sa.biz
www.gcs-sa.biz

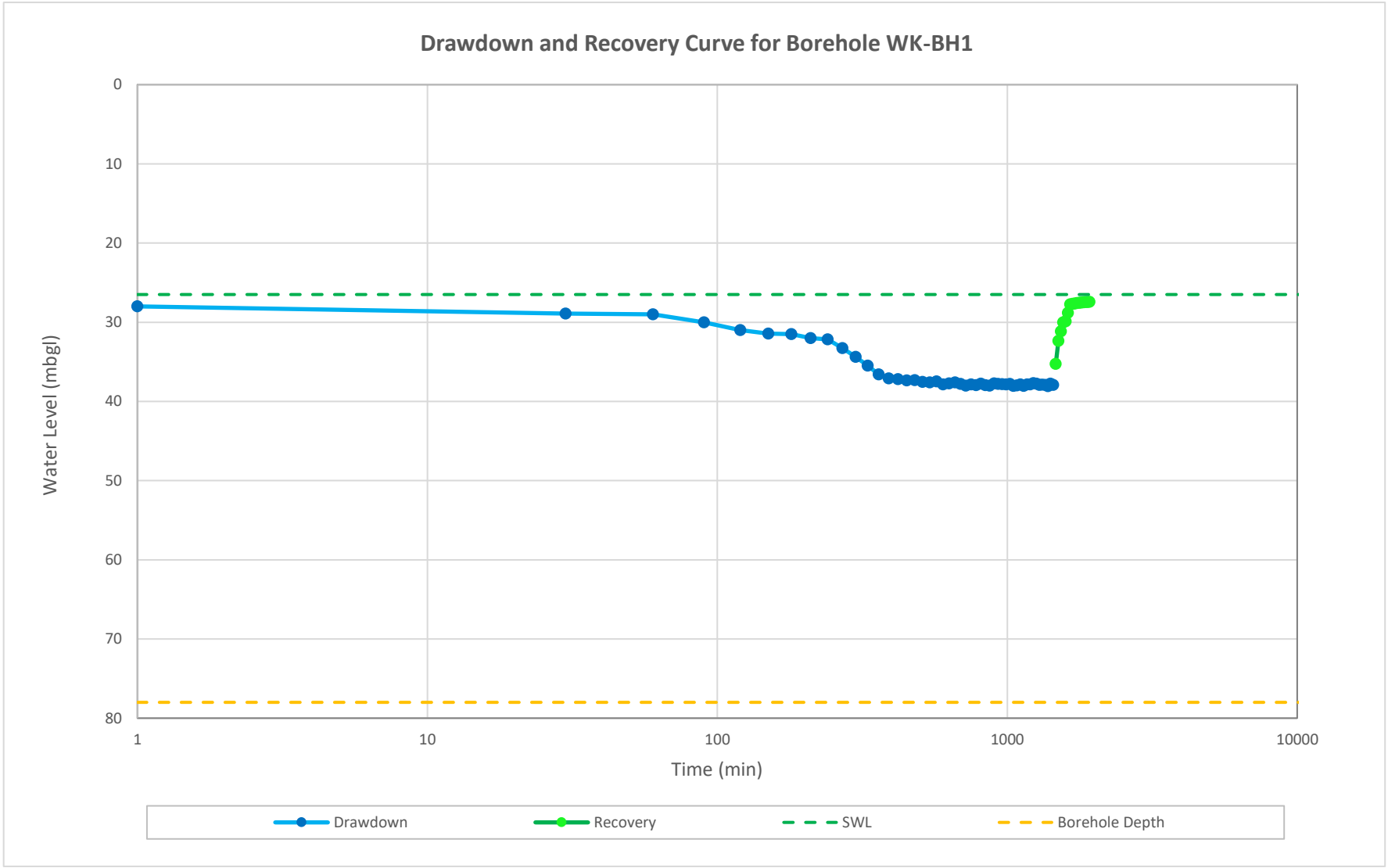


Figure 5-2: Aquifer Test Results for Borehole WK-BH1

6 LABOROTORY ANALYSIS

Groundwater samples were collected from production borehole WK-BH1 and submitted to an accredited laboratory for inorganic analysis. The laboratory certificate is attached in Appendix A. The laboratory results were compared to the following standards:

- SANS 241-1:2015 drinking water quality standards (SABS, 2015).

Table 6-1: Groundwater Laboratory Results

Parameters	SANS 241-1: SANS 2015 Drinking Water Standard Limits	Sample ID
		WK-BH1
General Parameters		
pH at 22ºC (pH units)	≥5 to ≤9.7 [O]	8.2
Conductivity mS/m @ 25 °C	≤170 [A]	61
Total dissolved solids (TDS)	≤1200 [A]	340
Total Alkalinity as $CaCO_3$	NS	169
Turbidity (NTU)	NS	150
Bicarbonate, HCO_3	NS	206
Carbonate, CO_3	NS	<12
Anions		
Chloride, Cl	≤300 [A]	58
Sulphate, SO_4	≤500 [AH]	73
	≤250 [A]	
Nitrate as N	≤11 [AH]	1.1
Nitrate as NO_3	≤50 [AH]	5
Nitrite as N	≤0.9 [AH]	<0.02
Nitrite as NO_2	≤3.0 [AH]	<0.05
Fluoride, F	≤1.5 [CH]	0.21
Cations and Metals		
Calcium, Ca	NS	42
Magnesium, Mg	NS	24
Sodium, Na	≤200 [A]	37
Potassium, K	NS	5.4
Iron, Fe	≤2 [CH]	<0.05
	≤0.3 [A]	
Aluminium, Al	≤0.3 [O]	<0.02
Manganese, Mn	≤0.4 [CH]	0.12
	≤0.1 [A]	
Boron, B	≤2.4 [CH]	0.088
Microbiological		
All parameters in mg/l unless specified otherwise		
Blue Shading: Exceedance in terms of SANS 241-1:2015 Drinking Water Standard		
[A] - SANS 241-1 Aesthetic Risk Limit		

CH - SANS 241-1 Chronic Health Risk Limit
AH - SANS 241-1 Acute Health Risk Limit
O - SANS 241-1 Operational Risk Limit
NS- No Standard
NS- No Standard

*Exceeds SANS 2015: Drinking Water Quality Standard

6.1.1 General Parameters

All general parameters are compliant of the SANS241-1:2015 Standards.

6.1.2 Anions

All general parameters are compliant of the SANS241-1:2015 Standards.

6.1.3 Cations and Metals

All general parameters are compliant of the SANS241-1:2015 Standards.

6.2 Piper Diagram

A piper diagram represents the chemistry of a water sample graphically. It is a tri-linear diagram that implements major cations calcium, magnesium, sodium and potassium) and anions (chloride, sulphate and bicarbonate) to reveal the chemistry of water samples. This is then used to characterize different types of water. The sample WK-BH1 analyzed was a magnesium bicarbonate type with water plotting in the unpolluted groundwater region on the graph (refer to Figure 6-1). The piper diagram can also be used to verify if the groundwater is being contaminated by examining pollution trends (piper diagrams of groundwater samples over time).

Project:	19-0902
Location:	EXXARO Leeuwpan Coal Mine
Laboratory:	X-Lab Earth
Date Analysed:	10/12/2019

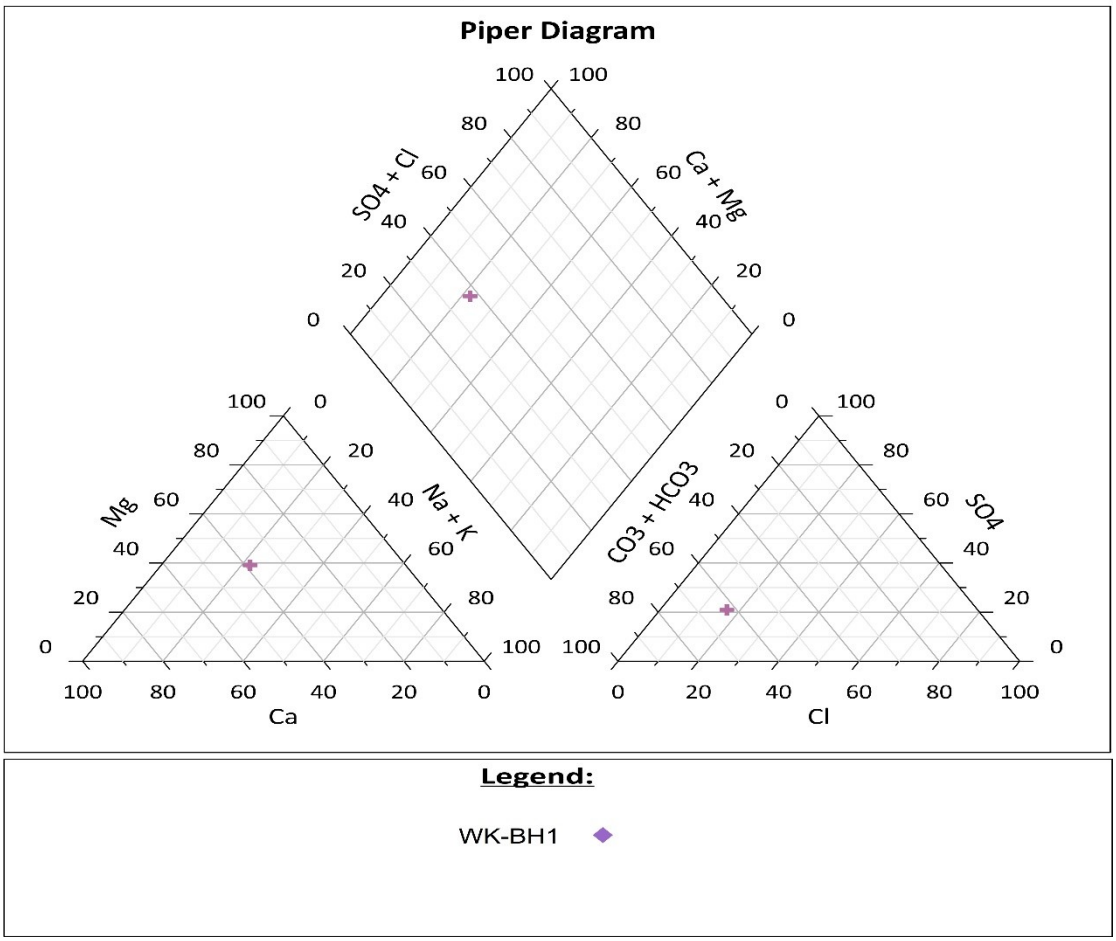


Figure 6-1: Piper Diagram for Sample WK-BH1

7 GROUNDWATER RESERVE DETERMINATION

7.1 Quaternary Catchment

Data from relevant hydrogeological databases including, the Groundwater Resource Directed Measures (GRDM) was obtained from the Department of Water and Sanitation. The site falls within quaternary catchment B20A as indicated in Table 7-1.The recharge for the quaternary catchment is 6.6 mm/a which amounts to 10% of the mean annual precipitation of 661.2 mm/a.

Table 7-1: Quaternary Catchment Details for Catchment B20A

Quaternary Catchment	Total Area	Recharge	Rainfall	Current use	Groundwater level
[-]	[km²]	[mm/a]	[mm/a]	[L/s]	[mbgl]
B20A	574.3	6.6	661.2	48.2	15

Note/s:

[-]	-	not applicable
[km²]	-	square kilometers
[mm/a]	-	millimeter / annum
[L/s}	-	Liters / second
[mbgl]	-	meters below ground level

7.2 Sub-catchment Delineation

In order to delineate a sub-catchment for the site within the quaternary catchment ArcGIS is used (which provides a method to describe the physical characteristics of a surface). Using a digital elevation model as input, it is possible to delineate a drainage system and then quantify the characteristics of that system. The tools in the extension let you determine, for any location in a grid, the upslope area contributing to that point and the down slope path water would follow. This data is important during the numerical model boundary selection and impact assessment. The delineated sub-catchment is presented in Figure 7-1.

Dolomitic compartments are referred to when cross cutting dykes act as barriers to groundwater flow creating isolated hydrogeological compartments. The production borehole WK-BH1 is situated in the Delmas compartment (Meyer, 2014). The recharge from a karst aquifer system is not only dependent on the recharge from within a sub-catchment. The delineated sub-catchment shown in was therefore not used to calculated the groundwater reserve available for abstraction and in order to verify the impacts associated with abstracting groundwater from the karst aquifer system it is recommended that the groundwater model (GCS, 2019) attached in **Appendix C** be referred to.

7.2.1 Registered Abstraction

No registered groundwater users are located within the sub-catchment containing the site or within the close vicinity of the production borehole. This is based on data made available by the Water Registration Management System (WARMS).

Table 7-2: WARMS Borehole Details for Quaternary Catchment B20A

Name	Latitude	Longitude	Register Status	WU Sector	Registered Volume
[-]	[DD]	[DD]	[-]	[-]	[m^3/a]
24009582	-25.98515	28.58997	CLOSED	AGRICULTURE: IRRIGATION	190 020
24011935	-26.26667	28.58997	ACTIVE	AGRICULTURE: IRRIGATION	872 400
24012783	-26.17000	28.76000	ACTIVE	AGRICULTURE: IRRIGATION	848 409
24014610	-26.01000	28.70000	ACTIVE	AGRICULTURE: IRRIGATION	19 000
24015414	-26.20000	28.76000	ACTIVE	AGRICULTURE: IRRIGATION	127 820
24015557	-26.16000	28.73000	CLOSED	AGRICULTURE: IRRIGATION	168 100
24016896	-26.15000	28.80000	ACTIVE	AGRICULTURE: IRRIGATION	2 735
24023316	-26.22000	28.69000	ACTIVE	AGRICULTURE: IRRIGATION	320 000
24024823	-26.17361	28.63500	ACTIVE	AGRICULTURE: IRRIGATION	24 000
24026377	-25.98515	28.58997	CLOSED	AGRICULTURE: IRRIGATION	46 480
24029285	-26.23750	28.73194	ACTIVE	AGRICULTURE: IRRIGATION	90 200
24029347	-25.13020	28.77940	CLOSED	AGRICULTURE: IRRIGATION	3 390
24029962	-26.13000	28.72000	ACTIVE	AGRICULTURE: IRRIGATION	110 550
24030004	-26.69000	28.69000	CLOSED	AGRICULTURE: IRRIGATION	120 200
24031414	-26.17000	28.65889	ACTIVE	AGRICULTURE: IRRIGATION	12 000
24031423	-26.17361	28.64333	ACTIVE	AGRICULTURE: IRRIGATION	31 950
24031539	-26.18000	28.75000	ACTIVE	AGRICULTURE: IRRIGATION	511 280
24031744	-26.14000	28.73000	ACTIVE	AGRICULTURE: IRRIGATION	171 000
24031815	-26.12350	28.71020	ACTIVE	AGRICULTURE: IRRIGATION	160 000
24032681	-26.12000	28.74000	ACTIVE	AGRICULTURE: IRRIGATION	730 150
24033644	-26.17000	28.65972	ACTIVE	AGRICULTURE: IRRIGATION	28 000
24033653	-26.17361	28.66000	ACTIVE	AGRICULTURE: IRRIGATION	36 000
24033706	-26.16667	28.61667	ACTIVE	AGRICULTURE: IRRIGATION	1 448 000
24033779	-26.17083	28.65889	ACTIVE	AGRICULTURE: IRRIGATION	244 000
24033788	-26.14000	28.65000	ACTIVE	AGRICULTURE: IRRIGATION	597 600
24034377	-26.13333	28.61667	CLOSED	AGRICULTURE: IRRIGATION	14 210
24034509	-26.03382	28.58997	ACTIVE	AGRICULTURE: IRRIGATION	518
24034509	-26.03307	28.58997	ACTIVE	AGRICULTURE: IRRIGATION	1 440
24034509	-26.03291	28.58997	ACTIVE	AGRICULTURE: IRRIGATION	1 584
24035544	-26.03000	28.75000	ACTIVE	AGRICULTURE: IRRIGATION	9 560
24035624	-26.14000	28.74000	CLOSED	AGRICULTURE: IRRIGATION	290 800
24035688	-26.04360	28.67780	ACTIVE	AGRICULTURE: IRRIGATION	5 775
24035688	-25.98515	28.58997	ACTIVE	AGRICULTURE: IRRIGATION	28 780
24035731	-26.12130	28.67750	ACTIVE	AGRICULTURE: IRRIGATION	29 200
24041859	-25.98515	28.58997	ACTIVE	AGRICULTURE: IRRIGATION	31 530

Name	Latitude	Longitude	Register Status	WU Sector	Registered Volume
24043045	-25.98515	28.58997	ACTIVE	AGRICULTURE: IRRIGATION	23 910
24046088	-26.14722	28.70639	CLOSED	AGRICULTURE: IRRIGATION	502 339
24046097	-26.09000	28.65417	CLOSED	AGRICULTURE: IRRIGATION	318 384
24046131	-25.98515	28.58997	CLOSED	AGRICULTURE: IRRIGATION	19 305
24054265	-26.16583	28.66528	ACTIVE	AGRICULTURE: IRRIGATION	424 000
24054283	-26.17361	28.64333	ACTIVE	AGRICULTURE: IRRIGATION	34 200
24054309	-26.17361	28.63500	ACTIVE	AGRICULTURE: IRRIGATION	36 000
24054327	-26.17361	28.63500	ACTIVE	AGRICULTURE: IRRIGATION	24 000
24055442	-26.15000	28.62000	CLOSED	AGRICULTURE: IRRIGATION	1 825
24057191	-26.17000	28.76000	ACTIVE	AGRICULTURE: IRRIGATION	203 560
24057217	-26.16000	28.67000	ACTIVE	AGRICULTURE: IRRIGATION	858 945
24057379	-26.17000	28.65889	ACTIVE	AGRICULTURE: IRRIGATION	12 000
24057388	-26.17000	28.65889	ACTIVE	AGRICULTURE: IRRIGATION	28 000
24067199	-25.98515	28.58997	ACTIVE	AGRICULTURE: IRRIGATION	240 000
24079453	-26.19890	28.63530	CLOSED	AGRICULTURE: IRRIGATION	529 720
24080682	-25.98515	28.58997	ACTIVE	AGRICULTURE: IRRIGATION	10 320
24083947	-26.09000	28.65417	ACTIVE	AGRICULTURE: IRRIGATION	318 384
24084571	-26.15000	28.62000	ACTIVE	AGRICULTURE: IRRIGATION	9 000
24084651	-26.14722	28.70639	ACTIVE	AGRICULTURE: IRRIGATION	502 339
24089175	-26.16489	28.72242	ACTIVE	AGRICULTURE: IRRIGATION	46 480
24090902	-26.17333	28.69000	ACTIVE	AGRICULTURE: IRRIGATION	120 200
24096283	-26.14000	28.74000	ACTIVE	AGRICULTURE: IRRIGATION	290 800
24097745	-26.14156	28.71750	ACTIVE	AGRICULTURE: IRRIGATION	103 680
24098575	-26.16000	28.73000	ACTIVE	AGRICULTURE: IRRIGATION	168 100
24015780	-26.02264	28.73686	ACTIVE	AGRICULTURE: WATERING LIVESTOCK	18 250
24026974	-26.25000	28.76667	ACTIVE	AGRICULTURE: WATERING LIVESTOCK	56 700
24049575	-26.07000	28.76000	ACTIVE	AGRICULTURE: WATERING LIVESTOCK	9 560
24049682	-25.98515	28.58997	ACTIVE	AGRICULTURE: WATERING LIVESTOCK	2 000
24073119	-26.16690	28.79110	ACTIVE	AGRICULTURE: WATERING LIVESTOCK	36 500
24029016	-26.07000	28.71000	ACTIVE	INDUSTRY (NON-URBAN)	3 000
24030004	-25.98515	28.58997	CLOSED	INDUSTRY (NON-URBAN)	16 600
24090902	-25.98515	28.58997	ACTIVE	INDUSTRY (NON-URBAN)	16 600
24026108	-26.14790	28.74970	ACTIVE	INDUSTRY (URBAN)	100 000
24099823	-26.12428	28.68050	ACTIVE	INDUSTRY (URBAN)	106 458
24099823	-26.12428	28.68050	ACTIVE	INDUSTRY (URBAN)	106 458
24099823	-26.12428	28.68050	ACTIVE	INDUSTRY (URBAN)	106 458
24009396	-26.15947	28.77272	ACTIVE	MINING	360 000
24009396	-26.16053	28.77194	ACTIVE	MINING	900 000
24009396	-26.15753	28.77922	ACTIVE	MINING	1 692
24009396	-26.16369	28.77083	ACTIVE	MINING	5 438

Name	Latitude	Longitude	Register Status	WU Sector	Registered Volume
24009591	-25.98515	28.58997	CLOSED	MINING	20 000
24059135	-25.98515	28.58997	ACTIVE	MINING	20 000
24059135	-25.98515	28.58997	ACTIVE	MINING	24 000
24059135	-25.98515	28.58997	ACTIVE	MINING	68 400
24059135	-25.98515	28.58997	ACTIVE	MINING	26 400
24059135	-25.98515	28.58997	ACTIVE	MINING	15 360
24059135	-25.98515	28.58997	ACTIVE	MINING	15 360
24059135	-25.98515	28.58997	ACTIVE	MINING	120
24095621	-26.16453	28.82142	ACTIVE	MINING	13 031
24095621	-26.16117	28.80747	ACTIVE	MINING	9 198
24095756	-26.19764	28.67767	ACTIVE	MINING	324 000
24098735	-26.22500	28.70028	ACTIVE	MINING	22 000
24098735	-26.22500	28.70028	ACTIVE	MINING	200 000
24099253	-26.13272	28.77411	ACTIVE	MINING	15 000
24099253	-26.13272	28.77411	ACTIVE	MINING	507
24099253	-26.13272	28.77411	ACTIVE	MINING	157 200
24100269	-26.11747	28.74819	ACTIVE	MINING	18 000
24100713	-26.16053	28.77194	COMPLETE	MINING	900 000
24100713	-26.16053	28.77194	COMPLETE	MINING	1 692
24100713	-26.16053	28.77194	COMPLETE	MINING	5 438
				TOTAL VOLUME IN [m^3/a]	**15 853 592**

Note/s:

[-]	-	not applicable
[DD]	-	decimal degrees
[m^3/a]	-	cubic meters / annum
Coordinates		Projection: Geographic Datum: WGS84

7.2.2 Theoretical Groundwater Balance

A theoretical groundwater balance was calculated for the sub-catchment to determine the surplus available for abstraction, as presented in WARMS Database Boreholes for quaternary catchment B20A The Water Use Registering, and Licensing database (WARMS) data was obtained from the Department of water affairs and Forestry and are shown in Table 7-4 below. The total volume of water abstracted for the quaternary catchment is 15 853 592 m^3 per annum. No registered users are located within the sub catchment containing the site as shown in Figure 7-1.

Table 7-3: Theoretical Groundwater Balance Calculation for Delineated Sub-catchment Containing the Site

General Information						
Quaternary Catchment	B20A					
Sub-Catchment						
Size	20.23	km^2				
	20 232 744	m^2				
Groundwater Recharge	43.64	mm/a				
	0.0436392	m/a				
	= 43.6	mm/a	x	20 232 744	m^2	
	= 882 940	m^3/a				
	= 2 419	m^3/day				
Basic Human Need				GRDM	24.59	m^3/day
Abstraction Volumes	Hydrocensus Boreholes				-	m^3/day
	On site Usage				1 440	m^3/day
	Current Usage from GRDM				4 164.48	m^3/day
Groundwater Contribution to Baseflow					11.10	m^3/a
					0.03	m^3/day
Total Use					1 599	m^3/day
Surplus Amount					819.83	m^3/day
Scale of Abstraction	66.11	of recharge (Class E, high volumes abstraction with use ranging from 65% - 95%)				

7.2.3 Theoretical Water Quantity

The recent status of a groundwater resource unit can be assessed in terms of sustainable use, observed ecological impacts or water stress. Since no information about ecological impacts of groundwater abstraction is available, the concept of water stress was applied for the classification process.

The concept of stressed water resources is addressed by the National Water Act but is not defined. Part 8 of the Act gives some guidance by providing the following qualitative examples of 'water stress':

- Where demands for water are approaching or exceed the available supply;
- Where water quality problems are imminent or already exist; or
- Where water resource quality is under threat.

To provide a quantitative means of defining stress, a groundwater stress index was developed by dividing the volume of groundwater abstracted from a groundwater unit by the estimated recharge to that unit (Parsons and Wentzel, 2007).

Stress Index = Groundwater Abstraction / (Recharge - Baseflow)

= 1599 / (2419 – 0.03)

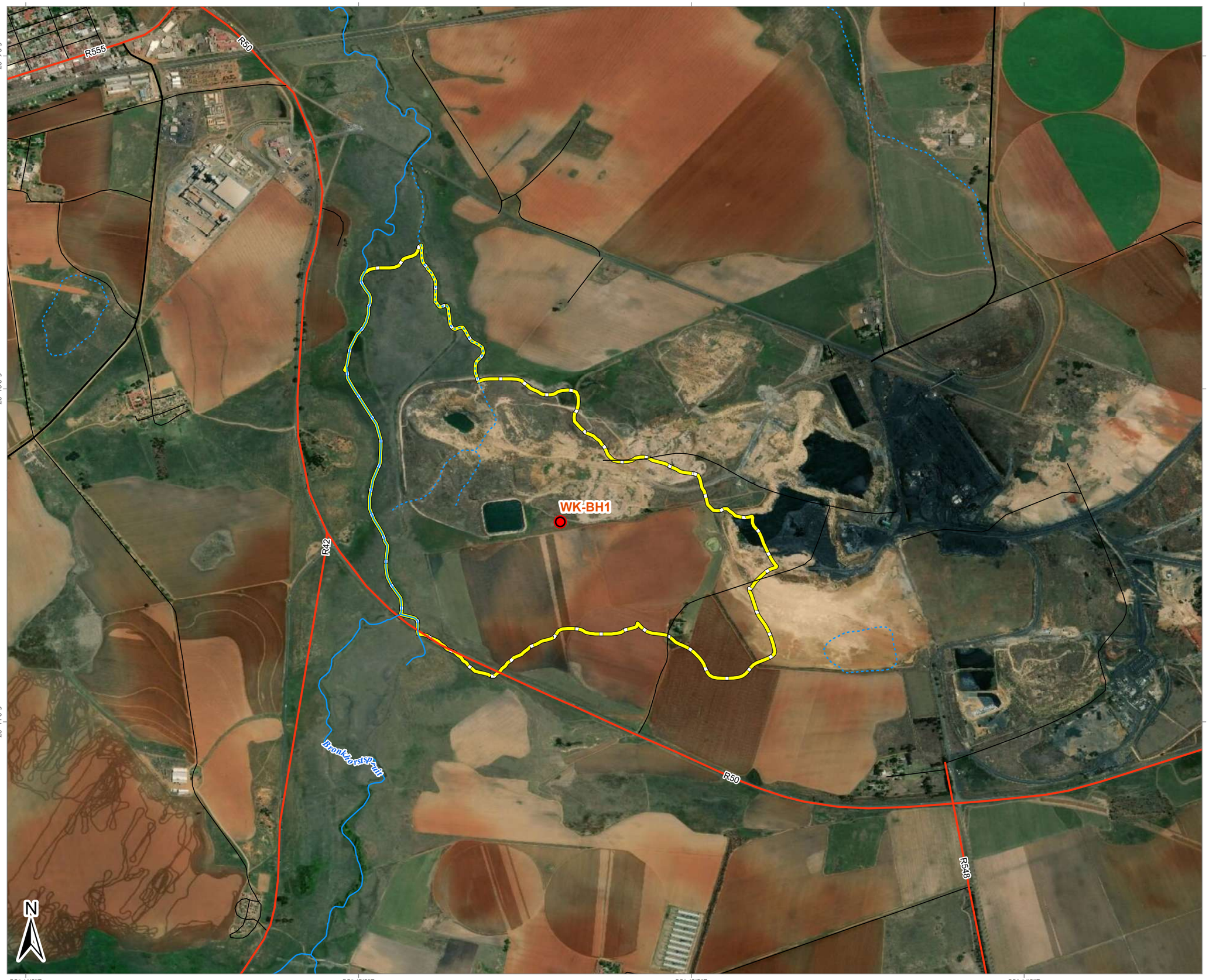
= **0.6611**

Table 7-4: Guide for determining the level of stress of a groundwater resource unit

Present Status Category	Description	Stress Index
A	Unstressed or low level of stress	<0.05
B		0.05-0.2
C	Moderate levels of stress	0.2 – 0.5
D		**0.5 – 0.75**
E	Highly Stressed	0.75 – 0.95
F	Critically stressed	>0.95

Based on the theoretical stress index the aquifer is under moderate levels of stress.

FIGURE 7-1: DELINEATED SUB-CATCHMENT MAP



LEGEND

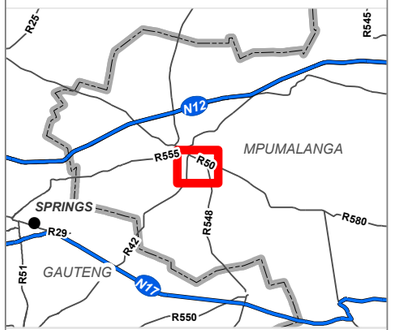
- Borehole

Rivers and Streams

- Non-Perennial
- Perennial

Road Network

- Main Road
- Secondary Road
- Street
- Sub-catchment



Data Sources:
Esri Basemap 2019
Sub-Catchment data derived from ALOS
ALOS World 3D - 30m (AW3D30) ©JAXA
Data supplied from Specialist (R Van Heerden)

0 250 500 Meters

SCALE: 1:20 000

FIGURE NO.:	-	MAP NUMBER:	19-0902-02
DRAWN BY:	A LOVE GIS CONSULTANT	REVIEWED BY:	C BOTHA GIS SPECIALIST
DATUM: PROJECTION:	WGS84 GEOGRAPHIC	DATE:	14 JANUARY 2020
PROJECT:	LEEUWPAN SECTION 21(A) WULA		
CLIENT:	EXXARO		

GCS Water & Environmental Consultants

63 Wessel Road Woodmead
PO Box 2597 Rivonia 2128
South Africa

Tel: +27 (0) 11 803 5726
Fax: +27 (0) 11 803 5745
E-mail: jhb@gcs-sa.biz
www.gcs-sa.biz

8 IMPACT ASSESSMENT

The following methodology was used to rank potential impacts. Clearly defined and ranking scales were used to assess the impacts associated with the proposed activities.

Each impact identified was rated according the expected magnitude, duration, scale and probability of the impact (refer to Table 8-8). Each impact identified was assessed in terms of scale (spatial scale), magnitude (severity) and duration (temporal scale). Consequence is then determined as follows:

Consequence = Severity + Spatial Scale + Duration

The Risk of the activity is then calculated based on frequency of the activity and impact, how easily it can be detected and whether the activity is governed by legislation. Thus:

Likelihood = Frequency of activity + frequency of impact + legal issues + detection

The risk is then based on the consequence and likelihood.

Risk = Consequence x likelihood

In order to assess each of these factors for each impact, the ranking scales in Table 8-1 to Table 8-7 were used.

Table 8-1: Severity

Insignificant / non-harmful	1
Small / potentially harmful	2
Significant / slightly harmful	3
Great / harmful	4
Disastrous / extremely harmful / within a regulated sensitive area	5

Table 8-2: Spatial Scale - How big is the area that the aspect is impacting on?

Area specific (at impact site)	1
Whole site (entire surface of site)	2
Local (within 5km)	3
Regional / neighbouring areas (5km to 50km)	4
National	5

Table 8-3: Duration

One day to one month (immediate)	1
One month to one year (Short term)	2
One year to 10 years (medium term)	3
Life of the activity (long term)	4
Beyond life of the activity	5

Table 8-4: Frequency of the activity - How often do you do the specific activity?

Annual or less	1
Bi-annually	2
Monthly	3
Weekly	4
Daily	5

Table 8-5: Frequency of the incident/impact - How often does the activity impact the environment?

Almost never / almost impossible / >20%	1
Very seldom / highly unlikely / >40%	2
Infrequent / unlikely / seldom / >60%	3
Often / regularly / likely / possible / >80%	4
Daily / highly likely / definitively / >100%	5

Table 8-6: Legal issues - How is the activity governed by legislation?

No legislation	1
Fully governed by legislation	5

Table 8-7: Detection - How quickly/easily can the impacts/risks of the activity be detected on the environment, people and property?

Immediately	1
Without much effort	2
Need some effort	3
Remote and difficult to observe	4
Covered	5

Environmental effects will be rated as either of high, moderate or low significance on the basis provided in Table 8-8.

Table 8-8: Impact Ratings

Rating	Class
1-55	(L) Low Risk
56 – 169	(M) Moderate Risk
170 - 600	(H) High Risk

8.1 Impact Assessment

The impact assessment results can be seen summarized in Table 8-9.

8.1.1 Operational Phase

Nature of impact: Abstraction of groundwater via the production borehole and lowering of the regional groundwater levels.

Mitigation Measures: The mitigation measures would include monitoring of the water levels and quality of the surrounding boreholes and the production borehole.

Significance: The impact will have medium negative significance.

Based on the impact assessment determined from a hydrogeological perspective it can be concluded that the abstraction of the groundwater will have a medium significant impact in the operational phase. It is recommended that the full impacts associated with the abstraction of groundwater from a karst or dolomitic aquifer be evaluated with a groundwater model.

Table 8-9: Impact Assessment Results

Impact description					Significance before mitigation	Significance after mitigation	Mitigation measures	Responsible Person
No.	Phases	Activity	Aspect	Impact				
1	Operation	Groundwater Abstraction	Groundwater Abstraction	Lowering of regional groundwater levels	M	M	The mitigation measures would include monitoring of the water levels and quality of the surrounding boreholes and the production borehole on site.	On site environmental representative

In order to fully estimate the impacts of the abstraction from borehole WK-BH1 it is recommended that the monitoring wells closest to the production well (WK-BH1) be monitored according to Table 8-10. It is also recommended that a deeper borehole that is situated within the dolomitic compartment be monitored. This will help quantify the impacts associated with the abstractions taking place.

8.1.2 Mitigation Plan

The following mitigation measures can be recommended in order to minimize any possible groundwater contamination as a result of the current abstractions:

- Storage of water in such a way that the evaporation thereof is minimal;
- Monitoring groundwater quality by sampling and submitting to a SANAS accredited laboratory;
- Ensure that measures are in place for the protection of the down hole equipment to prevent tampering, electrical surges and protect the pump from lightning;
- The area around the borehole should be graded to allow surface water run-off and to prevent surface water from ponding;
- Groundwater level monitoring of the abstraction boreholes to determine seasonal variations and long-term impact on water table due to abstraction.
- The data collected from the monitoring must be interpreted by a hydrogeologist in order to obtain a long-term time series understanding of the impacts of abstraction.

8.1.3 Groundwater monitoring plan

It is recommended that the water levels in the borehole WK-BH1 be electronically monitored with the use of a downhole water level monitoring device (level logger). summarizes the borehole information and monitoring frequency. The data obtained from this monitoring should be used to evaluate the recommended abstraction volumes. A flow meter should be fitted on the borehole and the volumes should be adjusted if a decline in water level is observed in the monitoring data. The locations of the boreholes mentioned in are shown in Figure 5-1.

Table 8-10: Water Level Monitoring Plan for WK-BH1

Borehole ID	Latitude	Longitude	Sampling Frequency	Method
[-]	[DD]	[DD]	[-]	[-]
WK-BH1	-26.17330	28.71013	Hourly	Electronic Water Level Monitor
WWNMB16	-26.178517	28.711015	Daily	Electronic Water Level Monitor
WWNO1	-26.174380	28.717220	Daily	Electronic Water Level Monitor
To be Verified	-	-	Hourly	Electronic Water Level Monitor

Groundwater sampling of all water sources used are also recommended on a bi- annual basis and according to the groundwater modelling report (GCS, 2019). The water quality should analysed by a hydrogeologist and be compared to historical groundwater quality standards in order to ensure that no pollution of the aquifer is taking place.

Table 8-11: Hydro chemical Sampling Plan for WK-BH1

Borehole ID	Water used for	Sampling Frequency	Analysis
WK-BH1	Mining (production)	Bi-annual	As per Table 6-1

9 CONCLUSION

General:

- The site is located to the south east of Delmas in the Victor Khanye Local Municipality, Mpumalanga;
- The study area is underlain by Sandstone, shale and coal beds of the Vryheid Formation intruded by Jurassic Dolerite;
- The area surrounding the site is mainly used for agricultural practices.

Field Investigation:

- One borehole is located on site and is used for mining purposes and the water is discharged into a holding dam;
- During the aquifer testing it was determined that if the pumping schedule is followed as per Table 5-3, then a total volume of 1 440 000 liters can be abstracted from the borehole on a daily basis.

Groundwater Quality:

- The laboratory results revealed that no constituents analysed for exceeded the SANS241-1:2015 Standards.

Groundwater Reserve Determination:

- The production borehole is situated within the Delmas dolomitic compartment and it is therefore recommended that the GCS (2019) report be referred to.
- The theoretical reserve however indicated that sufficient water is available for abstraction.

Groundwater Impact:

- The Groundwater impact was identified to be low should all monitoring and mitigation be adhered to.

Recommendations:

- It is recommended that the groundwater levels and the hydrochemistry of the borehole be monitored as per the mitigation plan in section 8.1.3 in this report;
- Water should be used sparingly, and all leaks and faulty reticulation should be attended to as soon as detected;
- The data collected from the monitoring must be interpreted by a hydrogeologist in order to obtain a long-term impacts of abstraction;
- It is recommended that the abstraction volumes from borehole WK-BH1 be included in the GCS groundwater model (2019) report (PN: 19-0297) attached as an addendum to this report (attached in **Appendix C)**; and
- The theoretical groundwater balance was prepared for the sub-catchment with the current abstraction volumes as set out in the scope of work, however the full impact of the abstraction taking place will only be appreciated once the groundwater model has been updated.

10 REFERENCES

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APPENDIX A: LABORATORY CERTIFICATE

TEST REPORT

CLIENT DETAILS		LABORATORY DETAILS	
Contact	Rudolf Van Heerded	Laboratory	X-Lab Earth Science
Client	GCS - GROUNDWATER CONSULTING SERVICES (PTY) LTD	Address	259 Kent Avenue Ferndale, 2194
Address	63 Wessel Road Rivonia Sandton	Telephone	+27 (0)11 590 3000
Telephone		Laboratory Manager	Mrs Tasneem Tagari
Facsimile		Lab Reference	JBX19-4630
Email	rudolfh@gcs-sa.biz	Report Number	0000012913
		Date Received	03/12/2019 09:54
Order Number	19-0902	Date Started	5/12/2019 10:30
Samples	1	Date Reported	10/12/2019 23:56
Sample matrix	WATER		

The document is issued in accordance with SANAS's accreditation requirements.
Accredited for compliance with ISO/IEC 17025. SANAS accredited laboratory

T0775

SIGNATORIES

Tasneem Tagari

General Manager/Technical Signatory

TEST REPORT

Parameter	Units	LOR	Sample Number: JBX19-4630.001 Sample Name: WK-BH2

Calculation of Anion-Cation Balance

Anion-Cation Balance	%	-100	-6.21
Sum of Anion Milliequivalents	meq/l	-	6.60
Sum of Cation Milliequivalents	meq/l	-	5.83

Colour Analysis by Discrete Analyser Method: ME-AN-039

Colour (True)	Hazen/l	1	<1.0

Turbidity Method: ME-AN-008

Turbidity *	NTU	0.4	150

Alkalinity on waters by titration Method: ME-AN-001

Total Alkalinity as CaCO3	mg/l	12	169
Bicarbonate Alkalinity as HCO3	mg/l	12	206
Bicarbonate as CaCO3	mg/l	12	169
Carbonate Alkalinity as CaCO3	mg/l	12	<12
Carbonate Alkalinity as CO3	mg/l	12	<12

Conductivity on waters Method: ME-AN-007

Conductivity in mS/m @ 25ºC	mS/m	2	61

Total Dissolved Solids (TDS) in water at 105 deg Method: ME-AN-011

TDS (0.7µm) @ 105ºC	mg/l	21	340

ICP-OES Metals on waters (Dissolved) Method: ME-AN-027

Aluminium	mg/l	0.02	<0.02
Boron	mg/l	0.005	0.088
Calcium	mg/l	0.5	42
Iron	mg/l	0.05	<0.05
Magnesium	mg/l	0.01	24

TEST REPORT

Parameter	Units	LOR	Sample Number: JBX19-4630.001 Sample Name: WK-BH2

ICP-OES Metals on waters (Dissolved) Method: ME-AN-027 (continued)

Manganese	mg/l	0.01	0.12
Potassium	mg/l	0.2	5.4
Silicon	mg/l	1	9.9
Sodium	mg/l	0.5	37

Anions on Waters by Ion Chromatography Method: ME-AN-014

Chloride	mg/l	0.05	58
Fluoride	mg/l	0.05	0.21
Nitrate	mg/l	0.1	5.0
Nitrate as N	mg/l	0.03	1.1
Nitrite	mg/l	0.5	<0.5
Nitrite as N	mg/l	0.2	<0.2
Sulphate	mg/l	0.05	73

pH in water Method: ME-AN-016

pH in water at 25ºC	-	1	8.2

METHOD SUMMARY

METHOD	METHOD SUMMARY
ME-AN-016	The pH of an aliquot of aqueous sample is measured electrometrically using an electrode connected to a calibrated meter with automated temperature correction. This method is based on APHA 4500-H B.
ME-AN-007	The conductivity of an aliquot of aqueous sample is measured electrometrically using a standard cell connected to a calibrated meter with automated temperature correction. This method is based on APHA 2510.
ME-AN-001	An aliquot of aqueous sample is titrated first to pH 8.3 and then to 4.3 using standardised acid. The volumes of acid titrated are used to calculate total alkalinity and/or alkaline species. The method is based on EPA 310.2 and APHA 2320 B.
ME-AN-011	Total dissolved solids (TDS) is determined gravimetrically on a filtered aliquot of aqueous sample by evaporating the sample to dryness in a pre-weighed container at 105 deg C. The method is based on APHA 2540 C.
ME-AN-039	This method is based on: Standard methods for the examination of water and wastewater, 18th edition, 1992. Colour 2120 C. Spectrophotometric method. The sample is filtered through a 0.45 µm filter and the true colour is determined spectrophotometrically at a wavelength of 575 nm
ME-AN-008	Turbidity is measured on an aliquot of aqueous sample using a calibrated turbidity meter. The method is based on APHA 2130.
ME-AN-014	Inorganic anions (Br, Cl, F, NO3, NO2, SO4) are determined on aqueous samples by ion chromatography. The method is based on EPA 300.1 and APHA 4110 B.
ME-AN-027	Dissolved metals are determined on a filtered and acidified (to 1% HNO3) portion of aqueous sample by inductively coupled plasma optical emission spectrometry (ICP-OES). The method is based on EPA 200.7 and APHA 3120.
Calculation of Anion-	Calculation of the cation/anion balance

FOOTNOTES

IS	Insufficient sample for analysis.
LNR	Sample listed, but not received.
^	Performed by outside laboratory.
LOR	Limit of Reporting
QFH	QC result is above the upper tolerance
QFL	QC result is below the lower tolerance
-	The sample was not analysed for this analyte
*	Results marked “Not SANAS Accredited” in this report are not included in the SANAS Schedule of Accreditation for this laboratory / certification body / inspection body”.

Samples analysed as received.
Solid samples expressed on a dry weight

Unless otherwise indicated, samples were received in containers fit for purpose.

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LAB-QLT-REP-001

APPENDIX B: AQUIFER TEST RESULTS

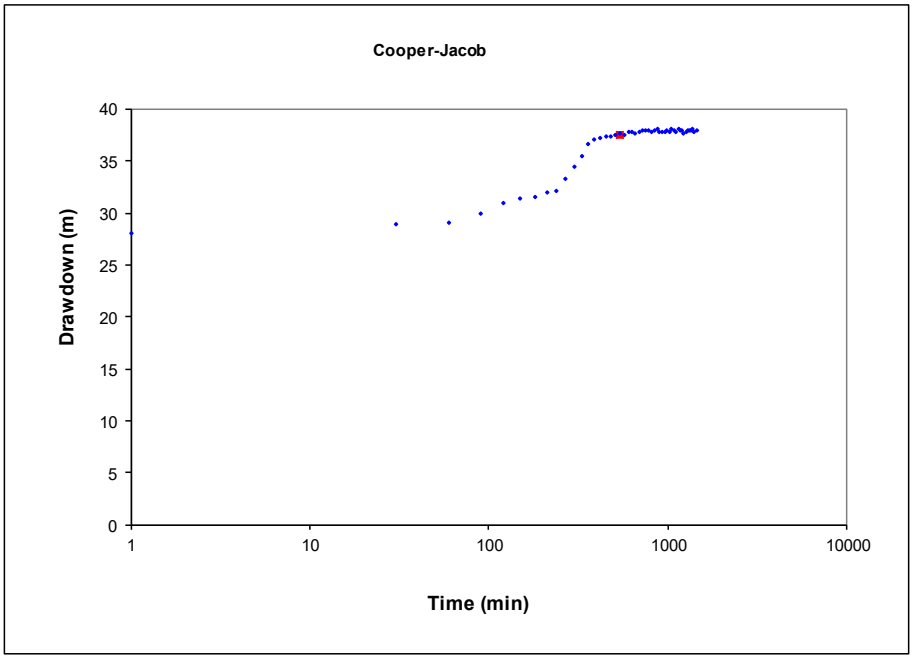
Transmissivity Calculation (T)	
Cooper-Jacob method	
Borehole ID	**WK-BH1**
Borehole Depth (meters)	78.00
Static Water Level (m)	28.00
Water Strikes (meters)	-
Distance from SWL Until Main Water Strike	-
Available Drawdown	-
(Hours: Minutes)	24:00
Date Completed	28/11/2019

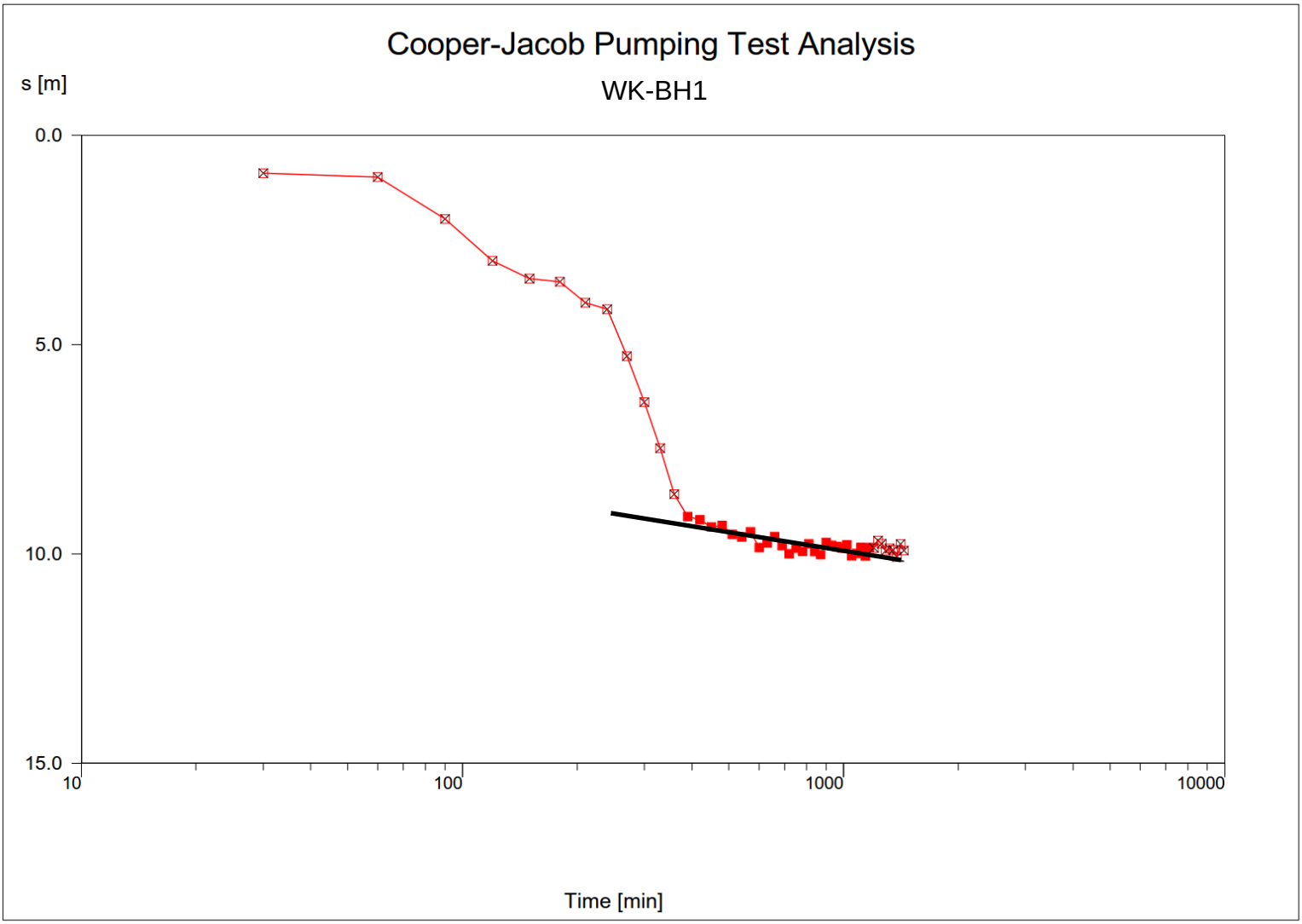
Transmissivity (m^2/d) =	289.8
Storativity	1.83E-30

r_e (m)=	0.08
Q (l/s) =	20

Boundary Conditions	No boundaries	1 no-flow	2 no-flow	Closed
Sustainable Yield (Sus Q)	13.56	6.78	4.47	3.39
Average Sus Q		7.05	std. dev =	4.56

Drawdown vs Time Trend for Borehole - ML BH1





PROJECT INFORMATION:

Company:	GCS
Client:	EXXARO
Project:	Leeuwpan Coal Mine - WULA Section 21(a)
Location:	Leeuwpan Coal Mine, Delmas, Mpumalanga
Test Well:	WK-BH1
Obs Well	None
Test Date:	28/11/2019

AQUIFER TEST DATA:

Saturated Thickness [m]:	50
Well Depth [m]:	78
Pump Yield [L/s]:	20
Volume Pumped Q [m^3/d]:	1 728
Transmissivity T [m^2/d]:	290
Test Start Date:	28/11/2019
Test End Date:	29/11/2019

SOLUTION:

Solution Method:	Cooper-Jacob Straight Line Method
Software used for Analysis:	Wish version 3.02.192c

APPENDIX C: GROUNDWATER MODEL REPORT (GCS, 2019)

Annexure C
Monthly Water Quality Report



MONTHLY WATER QUALITY REPORT

EXXARO Coal Mpumalanga (Pty) Ltd., Leeuwpan Coal Mine, located near Delmas, Mpumalanga Province.



PREPARED FOR:	EXXARO COAL MPUMALANGA (PTY) LTD. LEEUWPAN COAL MINE
PREPARED BY:	ENVASS
MONTH:	OCTOBER 2020
REPORT NUMBER:	MON-WQR-080-19_20 (20-10)
VERSION:	0.0

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ENVIRONMENTAL ASSURANCE (Pty)Ltd

DOCUMENT CONTROL	
Document Title	Exxaro Leeuwpan Monthly Water Quality Report
Report Number	MON-WQR-080-19_20 (20-10)
Version	0.0
Date	October 2020
Submitted to	Lucy Mogakane Environmental Practitioner Lucy.Mogakane@exxaro.com
Distribution	EXXARO Coal Mpumalanga (Pty) Ltd. Environmental Assurance (Pty) Ltd.

QUALITY CONTROL		
	Originated By	**Technical Review**
Name	Wian Esterhuizen	Anton Botha
Designation	Environmental Consultant	Environmental Consultant
Signature		
Date	28-10-2020	04-11-2020

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EXECUTIVE SUMMARY

Environmental Assurance (Pty) Ltd. (ENVASS) is appointed by EXXARO Coal Mpumalanga (Pty) Ltd. to implement and maintain an environmental compliance monitoring programme at the Leeuwpan Coal Mine, located near Delmas, Mpumalanga Province. The water quality monitoring program was initiated at Leeuwpan Coal Mine as per the Water Use License requirements, including; surface water sampling as well as reporting requirements. The surface water localities are monitored on a monthly basis.

This report communicates the monthly water monitoring and results conducted within October 2020. All monitoring was conducted according to recognised standards and sent to a SANAS accredited laboratory for analysis as further described in this report.

The following findings pertain to the October 2020 surface water monitoring:

- Four (4) water localities form part of the potable monitoring programme at Exxaro Leeuwpan Mine. It should be noted that the water is not used as a potable source, however monitored as such in case of accidental consumption as a precautionary measurement. The Load-Out Bay Offices (LLBDW) revealed exceedances of Electrical Conductivity, Total Dissolved Solids, Sulphate, Turbidity, Heterotrophic Plate Counts and *E.coli* which renders the water as not suitable for potable purposes. The Drinking Water Supply Tank (LDWST) presented an exceedance of Heterotrophic Plate Counts, while the majority of the parameters presented ideal water quality. The Drinking Water at Laboratory (LWDL) presented an exceedance of Electrical Conductivity, Total Dissolved Solids, Sulphate and Heterotrophic Plate Counts;
- The receiving environment monitoring localities presented exceedances of Ca, Mg, Turbidity, DOC and indicated presence of Oil and Grease;
- The process water samples revealed compliance to the stipulated WUL limits, except for the ODN-PIT monitoring point which exceeded the limit for *E.coli*;
- Representative samples related to October 2020 could not be obtained thus the final effluent from LWP-SP-P historically recorded non-compliant to the set Ammonia Wastewater WUL limits, while exceedances related to the General Authorisation limits included Suspended Solids, Ammonia and Chemical Oxygen Demand. During the monitoring period it was noted that the LWP-SP-P was not active and no access was obtained to the LWP-SP-W monitoring point;
- Samples LSW06, LSW07, LSW08, LSW12, WP01, RD1, KR03, KR04, OG PIT, OH PIT, OJ PIT, OM PIT, WLV PIT, LWP-SP-W, OWM-PIT and PIET-SCHUTTE could not be obtained during the monitoring period; and
- During the monthly monitoring period, the majority of the localities presented relatively stable conditions compared to September 2020, with fluctuation in bacteriological content noted.

TABLE OF CONTENTS

1. INTRODUCTION 1
2. SYSTEMS AUDIT 1
3. PURPOSE 1
4. METHODOLOGY 3
5. SCOPE OF WORK 4
   5.1 LABORATORY ANALYSIS 4
   5.2 SURFACE WATER MONITORING 5
6. RESULTS 11
   6.1 SURFACE WATER RESULTS 11
7. DISCUSSION 33
   7.1 RECEIVING ENVIRONMENT WATER QUALITY 33
   7.2 PROCESS WATER QUALITY 34
   7.3 EFFLUENT WATER QUALITY 34
   7.4 POTABLE WATER QUALITY 34
   7.5 EXCEEDING VARIABLE DISCUSSION 35
   7.6 CONCLUSION AND ASPECTS TO CONSIDER 38

APPENDIX A – SAMPLING REGISTER 39
APPENDIX B – PROBE FIELD MEASUREMENTS 50
APPENDIX C – SURFACE WATER GRAPHS 51
RECEIVING ENVIRONMENT GRAPHS 51
PROCESS WATER GRAPHS 53
EFFLUENT WATER GRAPHS 56
POTABLE WATER GRAPHS 59

LIST OF FIGURES

Figure 1: Leeuwpan Coal Mine Location Map 2
Figure 2: Receiving Environment Water Sampling Locality Map 7
Figure 3: Process Water Sampling Locality Map 8
Figure 4: Effluent Water Sampling Locality Map 9
Figure 5: Potable Water Sampling Locality Map 10
Figure 6: pH value 51
Figure 7: Electrical Conductivity 51
Figure 8: Total Dissolved Solids 52
Figure 9: Sulphate 52

Figure 10: *Escherichia coli* 53
Figure 11: pH value 53
Figure 12: Electrical Conductivity 54
Figure 13: Total Dissolved Solids 54
Figure 14: Sulphate 55
Figure 15: Oil and Grease 55
Figure 16: Nitrate 56
Figure 17: Suspended Solids 56
Figure 18: Ammonia 57
Figure 19: Nitrate 57
Figure 20: Ortho-Phosphate 58
Figure 21: Total Phosphate 58
Figure 22: Chemical Oxygen Demand (COD) 59
Figure 23: pH value 59
Figure 24: Turbidity 60
Figure 25: Electrical Conductivity 60
Figure 26: Heterotrophic Plate Count 61
Figure 27: Total Dissolved Solids 61

LIST OF TABLES

Table 1: Water Use License details 1
Table 2: Water quality parameters for Leeuwpan Coal Mine 4
Table 3: Surface Water Monitoring 5

GLOSSARY

A list of commonly used acronyms, measurement units and definitions are included below for the purpose of ensuring uniformity in the interpretation of this report:

Acronyms	
DWS	Department of Water and Sanitation (Formerly Department of Water Affairs and Forestry – DWAF and Department of Water Affairs - DWA)
EC	Electrical Conductivity
EMP	Environmental Management Programme
MDEDET	Mpumalanga Department of Economic Development, Environment and Tourism (Formerly Mpumalanga Department of Agriculture Land Administration – MDALA)
NEMA	National Environmental Management Act 107 of 1998
NWA	National Water Act 36 of 1998
PCD	Pollution control dam
SAR	Sodium Absorption Ratio
SHE	Safety, Health and Environment
WUL	Water Use License
Measurement Units	
Ha	Hectare
M	Meters
Mamsl	meters above mean sea level
mg/l	milligrams per litre
Definitions	
Pit	Any open excavation
Pollution control dam	A dam that forms part of a mine's water management system with the purpose to minimise the impact of polluted water on water resources, by separating clean and dirty water streams and capturing and retaining dirty water to prevent its discharge due to water quality constraints (DWAF, Best practice guideline A4: Pollution control dams, 2007).

1. INTRODUCTION

Environmental Assurance (Pty) Ltd. (ENVASS) was appointed by EXXARO Coal Mpumalanga (Pty) Ltd. to undertake the environmental compliance monitoring programme at Leeuwpan Coal Mine to fulfil the Water Use Licence Conditions (Licence no. **04/B20A/CIJ/4032**), approved on 18 December 2015.

The mining operation is located to the east of Delmas within the Victor Khanye Local Municipality. The mine is located within the Upper Olifants River Catchment. East of the mine, the Bronkhorstspruit flows as fed by a tributary running to the west of the mine. The underlying geology found in the area is comprised primarily of sedimentary rocks from the Karoo Supergroup with Dolerite intrusions featuring within the project area.

The monthly water quality monitoring at Leeuwpan Coal Mine consists of the monthly surface water quality monitoring as required in the WUL. The scope of work performed at the Leeuwpan Coal Mine is aligned to the WUL requirements, which are listed within the report.

2. SYSTEMS AUDIT

All monitoring points are presented within locality maps and are discussed under the relevant sections of this report. In all instances spatial scale was adjusted in order to present the position of all of the monitoring points relative to the mine and associated infrastructure.

The descriptions below (**Table 1**) provide extracts from the approved Water Use Licence (IWUL) number **04/B20A/CIJ/4032** to describe the environmental monitoring for this site.

Table 1: Water Use License details

Water Use Licence details	
Authorisation:	04/B21A/ABCGIJ/429
Date:	18 December 2015
Licensee:	Leeuwpan Coal Mine
Competent Authority:	Department of Water and Sanitation
Water Use authorised:	Section 21 (a, c, i, g & j)

3. PURPOSE

The purpose of this report is to test and report on the operational compliance as it relates to water quality conditions set out in the WUL and management requirements from the approved Department of Mineral Resources (DMR) Environmental Management Programme (EMPr).

- Various water samples are taken and analysed from the provided surface water localities.
- Surface water resources are monitored on a monthly basis.

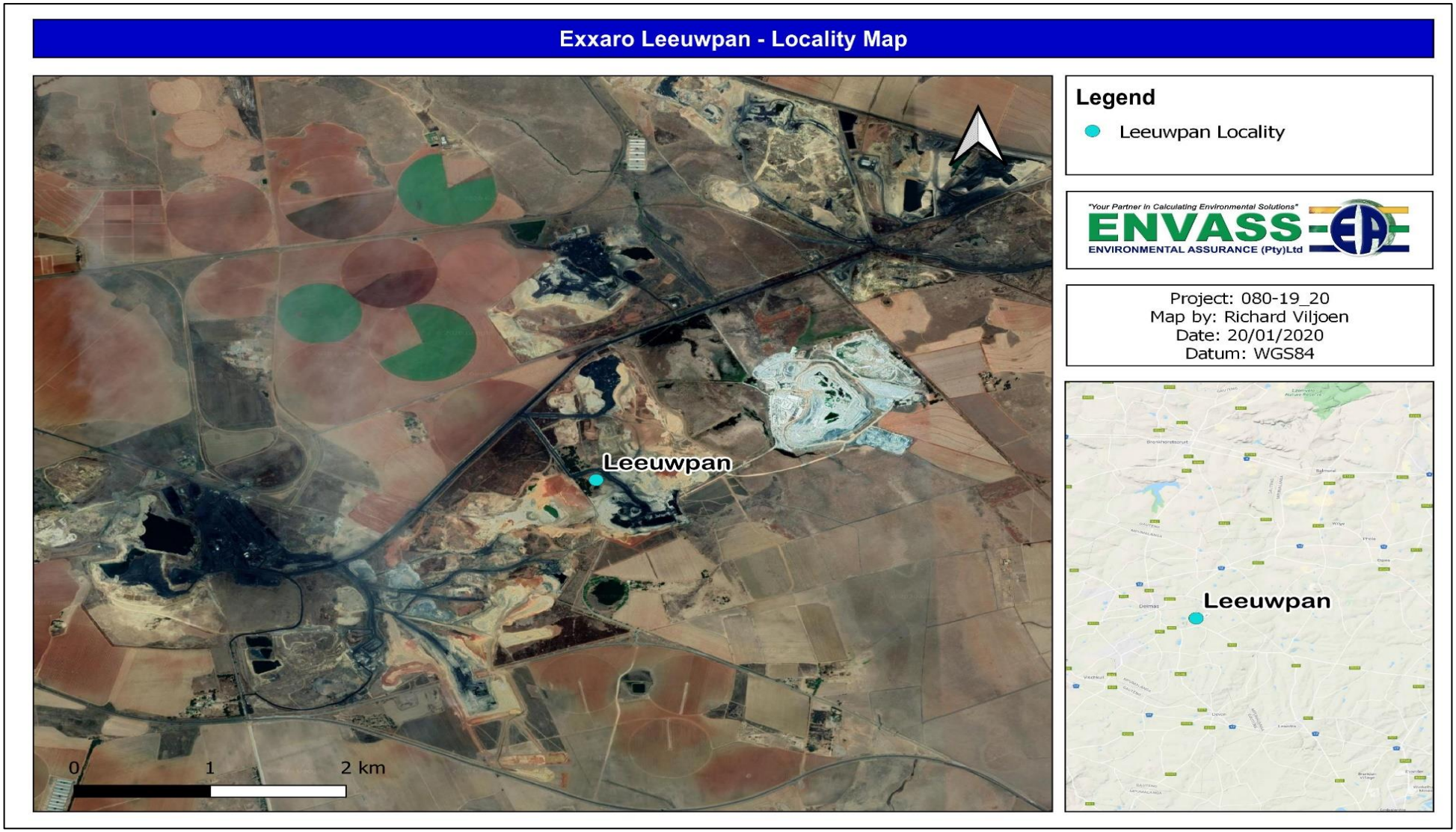


Figure 1: Leeuwpan Coal Mine Location Map

4. METHODOLOGY

All fieldwork is carried out by trained ENVASS environmental consultants and field technicians, fully trained in all of the methods of sampling as required. This includes as a minimum sampling for surface and groundwater.

Sampling at the selected Leeuwpan Coal sites will be in accordance with the following guidelines:

- Guidance on the design of sampling programs and sampling techniques

  ISO 5667-1:2006/SANS 5667-1:2008

- Guidance on the preservation and handling of water samples

  SANS 5667-3:2006/ISO 5667-3:2003

  (SABS ISO 5667-3)

- Guidance on sampling of drinking water from treatment works and piped distribution systems

  SANS 5667-5:2006/ISO 5667-5:2006

  (SABS ISO 5667-5)

- Guidance on sampling of rivers and streams

  SANS 5667-6:2006/ISO 5667-6:2005

  (SABS ISO 5667-6)

- Guidance on sampling of waste waters

  SANS 5667-10:2007/ISO 5667-10:1992

- Guidance on quality assurance of environmental water sampling and handling

  SANS 5667-14:2016/ISO 5667-14:2014

- DWAF Best Practice Guidelines Series G3: General Guidelines for Water Monitoring Systems.

Water sampling locations are set out in the WUL and/or received from the mine and previous sampling reports; and ultimately these samples are used to identify areas of concern and areas from which water could effectively leave the site into some form of receiving environment.

This report is prepared by ENVASS, drawing from the following sources of information:

- Water Use License (**04/B21A/ABCGIJ/429**) (Waste Water Limits);
- General Authorisation Limits (Process and Effluent Water)
- SANS 241: 2015 standards (Potable Water);
- DWAF Domestic Target Water Quality (Surface Water as comparison);
- A site visit to the Leeuwpan and surrounding areas; and
- Result of water samples analysed.

5. SCOPE OF WORK

Leeuwpan Coal Mine's water quality is actively monitored as set out in the following water quality monitoring programme:

- Various water samples are taken and analysed from the provided surface water localities on a monthly basis.

5.1 LABORATORY ANALYSIS

All samples are submitted to a SANAS accredited laboratory, Yanka Laboratories (Accreditation No. T0647) and are analysed according to ISO/IEC 17025:2005 standards. Annual triplicate samples are submitted to Waterlab (Accreditation No. T0391) a third-party laboratory for quality assurance. The following packages form part of the monitoring at Leeuwpan Coal Mine:

Table 2: Water quality parameters for Leeuwpan Coal Mine

General Analysis Package	Potable Water	Surface Water	Treated Sewage
pH	X	X	
Electrical conductivity	X	X	
Total Dissolved Solids	X	X	
Suspended Solids			X
Total Hardness	X	X	
Total Alkalinity	X	X	
Calcium	X	X	
Magnesium	X	X	
Sodium	X	X	
Potassium	X	X	
Fluoride	X	X	
Chloride	X	X	
Sulphate	X	X	
Iron	X	X	
Manganese	X	X	
Aluminium	X	X	
Boron		X	
Hexavalent Chromium		X	
Ammonia	X	X	X
Nitrate	X	X	X
Total inorganic nitrogen (TIN)		X	
Ortho-Phosphate	X	X	X
Total Phosphate		X	X
Chemical oxygen demand (total)			X
Turbidity (in-situ)	X	X	
DO (in-situ)	X	X	

General Analysis Package	Potable Water	Surface Water	Treated Sewage
Dissolved Organic Carbon		X	
Sodium adsorption ratio (SAR)	X		
Oil & grease		X	
Chlorophyll-a		X	
Escherichia coli (*E.coli*)	X	X	X
Faecal Coliforms			X
Heterotrophic plate count	X		
Al, As, B, Ba, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Se, Si, Sr, Ti, V, Zn, Hg, La, Lu, Sb, Sn, Th and Tl	X		

5.2 SURFACE WATER MONITORING

Surface water monitoring is performed at thirty-three (33) surface sampling points (See Table 3 and 5). Monitoring is performed on a monthly basis and is tested for the variables as listed in Table 2 (Refer to the WUL for surface water requirements). The monthly sampling register of the surface water localities indicated in Table 3 have been summarised in **Appendix A**.

Table 3: Surface Water Monitoring

Surface Water Monitoring			
Sample ID	**Description**	**Latitude**	**Longitude**
Potable Water			
LDWST	Drinking Water Supply Tank	S26.18005	E28.73602
LLBDW	Load-out Bay Offices Drinking Water	S26.16590	E28.72990
LWDL	Drinking Water at Laboratory	S26.17128	E28.72797
PIET-SCHUTTE	Drinking Water on Piet Schutte's Farm	S26.14150	E28.80170
River / Stream			
WP01	Bronkhorstspruit tributary, upstream	S26.17799	E28.70221
WP02	Bronkhorstspruit tributary, downstream	S26.15510	E28.70260
LSW03	Bronkhorstspruit at Delmas Silica, downstream	S26.16279	E28.76881
LSW05	Bronkhorstspruit, downstream	S26.13750	E28.75700
LSW06	Weltevredenspruit, upstream	S26.14390	E28.79550
LSW07	Bronkhorstspruit, upstream	S26.18860	E28.77635
LSW08	Bronkhorstspruit, upstream of Block OI	S26.23022	E28.76264
LSW12	Downstream of River Diversion 2, Between RD2 and LSW05	S26.13610	E28.76410

LSW13	Water from Stuart Coal	S26.14380	E28.77560
RD1	Bronkhorstspruit at haul road	S26.14930	E28.76450
Process Water			
KR01A	Kenbar Return Water Dam	S26.18087	E28.72995
KR03	Downstream of workshop oil separator sump	S26.18197	E28.73827
KR04	Marsh area next to workshop road	S26.18672	E28.73381
LSW09	Pollution Control Dam	S26.16601	E28.72541
ODN_PIT	OD Pit Water (closed pit)	S26.17122	E28.72381
OG_PIT	OG Pit Water (backfilled pit)	S26.17119	E28.73397
OH_PIT	OH Pit Water (backfilled pit)	S26.16698	E28.75338
OJ_PIT	OJ Pit Water	S26.16854	E28.74505
OM_PIT	OM Pit Water	S26.17278	E28.74875
OWM_PIT	OWM (Moabsvelden) Pit Water	S26.14440	E28.79241
WLV-PIT	Weltevreden Pit	S26.12888	E28.76050
WP04	New Witklip Return Water Dam	S26.17234	E28.70640
Final Effluent			
LWP_SP_P	Final effluent from septic tanks at plant	S26.1716	E28.7302
LWP_SP_W	Final effluent at sewage plant behind workshop	S26.1812	E28.7396
Additional Samples			
Kenbar rehab	Backfilled former Kenbar Pit	S26.1735	E28.7333
OJ-O	Field Barrels for experimental work	Unknow	
OJ-S4-DISC	Field Barrels for experimental work		
OH-WEATH	Field Barrels for experimental work		
OL-OVB(2A+2B)	Field Barrels for experimental work		

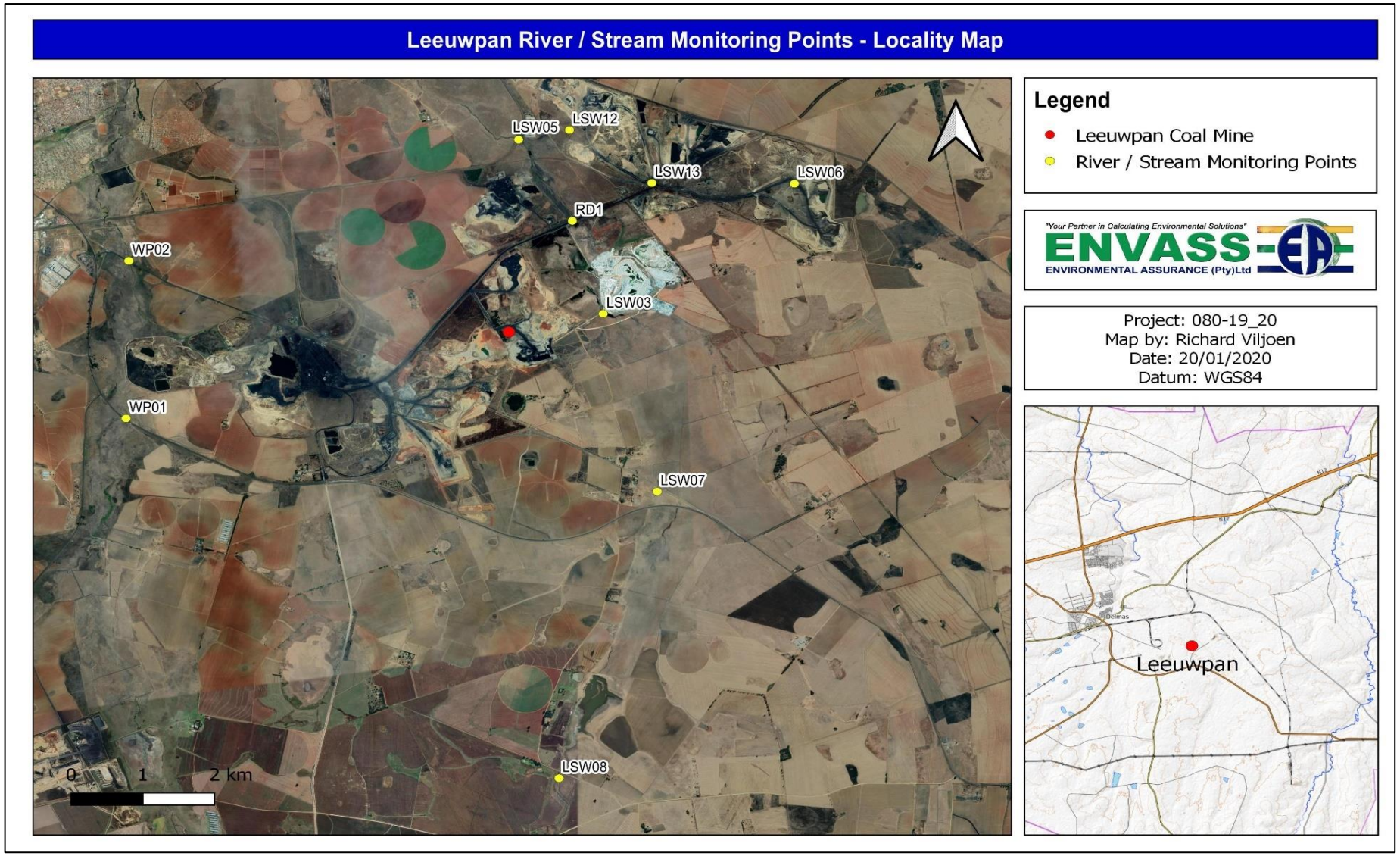


Figure 2: Receiving Environment Water Sampling Locality Map

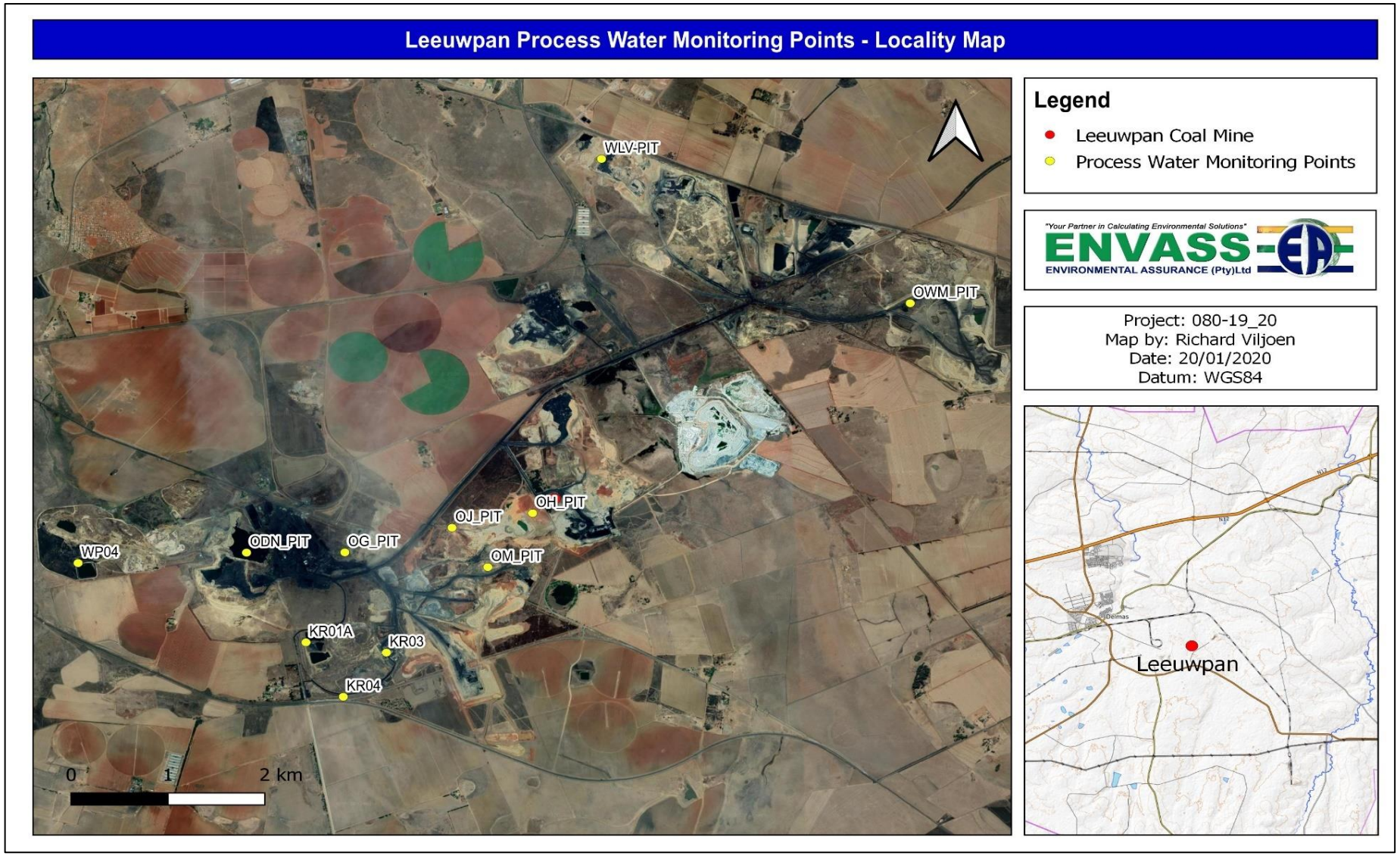


Figure 3: Process Water Sampling Locality Map

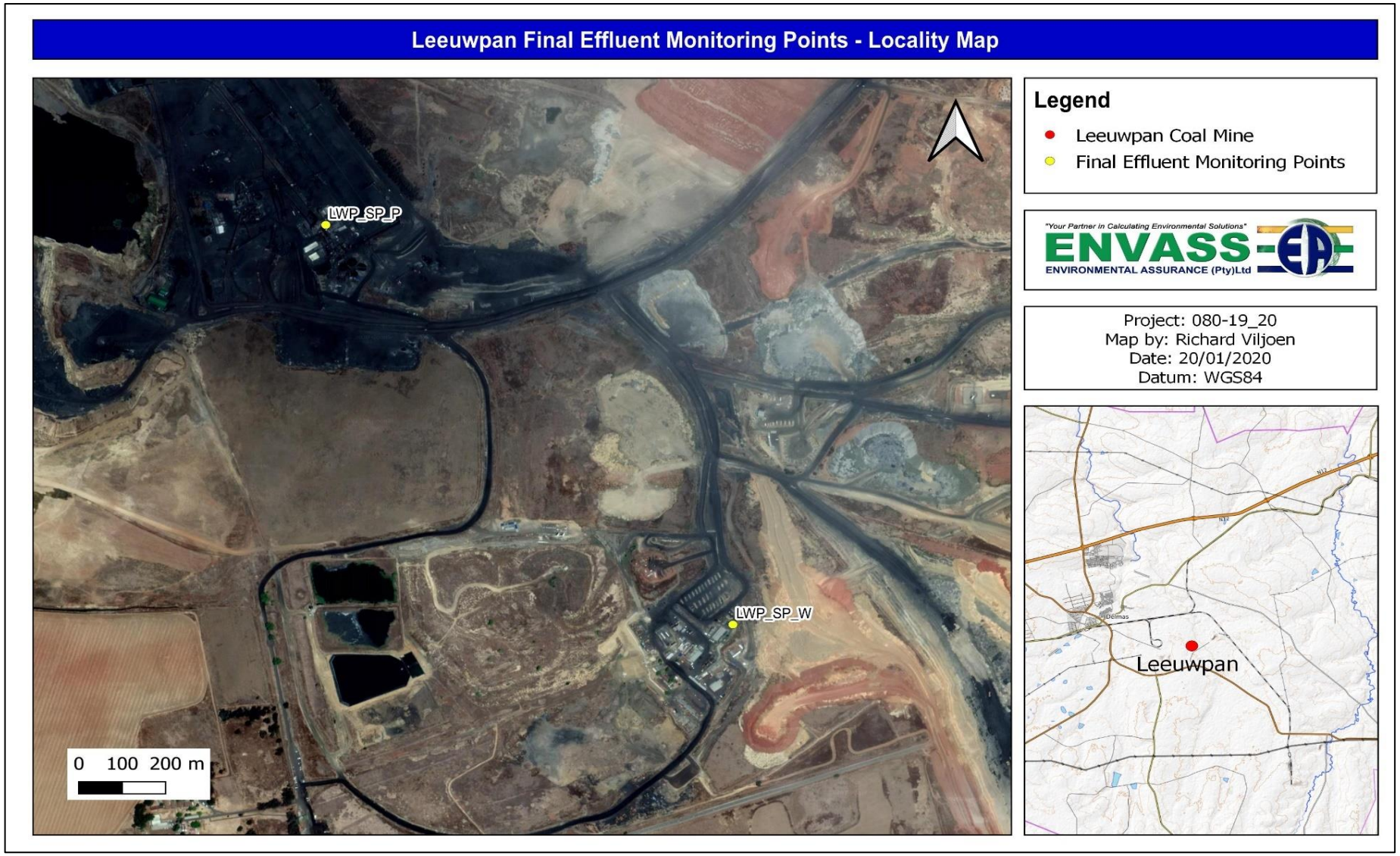


Figure 4: Effluent Water Sampling Locality Map

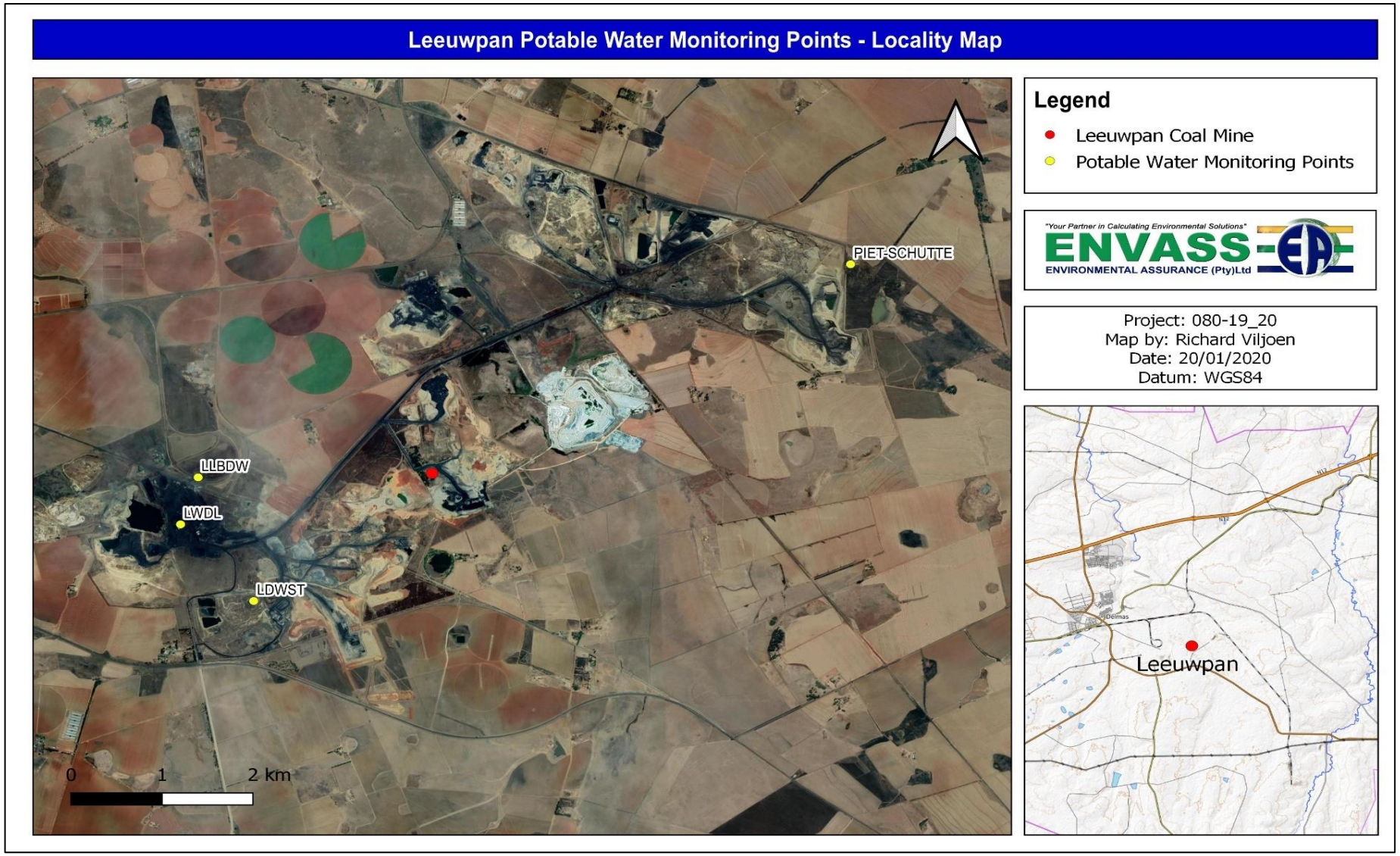


Figure 5: Potable Water Sampling Locality Map

6. RESULTS

6.1 SURFACE WATER RESULTS

Table 4: Receiving Environment Water Sample Results

Exxaro Leeuwpan																														
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Boron (B)	Hexavalent Chromium (Cr^{6})	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Total Inorganic Nitrogen (mg/l)	Ortho Phosphate as P (mg/l)	Total Phospahte	Turbidity	Dissolved Oxygen (DO)	Dissolved Organic Carbon (DOC)	Oil & Grease	Chlorofyll-a	*Escherichia coli* (*E.coli*)
DWAF Domestic Target Water Quality Range			6.0 - 9.0	70	450	-	-	32	30	100	50	1	100	200	0.1	0.05	0.15	-	0.050	1	6	-	-	-	1	-	5	-	1	0
Surface Water																														
WP01	21/11/2019	Dry																												
	05/12/2019	Dry																												
	16/01/2020	Dry																												
	06/02/2020	Dry																												
	09/03/2020	Dry																												
	08/05/2020	Dry																												
	19/05/2020		7.52	51.7	303	248	187	44.0	33.6	14.3	7.50	<0.09	12.4	79.4	0.04	0.02	0.03	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	1.42	4.83	6.50	19.1	0.80	<0.001	62
	02/06/2020		7.78	51.2	307	250	187	45.7	33.0	15.1	7.18	<0.09	12.7	81.3	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.50	18.40	7.61	16.6	0.60	<0.001	0
	07/07/2020		8.25	54.5	290	258	260	51.5	31.5	11.1	6.97	<0.09	12.6	20.4	0.03	0.02	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.16	10.90	7.53	19.2	3.33	0.03	2
	13/08/2020		8.02	48.1	289	244	258	51.4	28.0	17.6	3.30	<0.09	7.8	25.7	<0.01	0.47	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.20	8.00	7.36	12.3	1.50	0.00	2
	08/09/2020	Dry																												
	02/10/2020	Dry																												

Exxaro Leeuwpan																														
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Boron (B)	Hexavalent Chromium (Cr^6)	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Total Inorganic Nitrogen (mg/l)	Ortho Phosphate as P (mg/l)	Total Phospahte	Turbidity	Dissolved Oxygen (DO)	Dissolved Organic Carbon (DOC)	Oil & Grease	Chlorofyll-a	*Escherichia coli* (*E.coli*)
DWAF Domestic Target Water Quality Range			6.0 - 9.0	70	450	-	-	32	30	100	50	1	100	200	0.1	0.05	0.15	-	0.050	1	6	-	-	-	1	-	5	-	1	0
Surface Water																														
WP02	20/11/2019		7.78	44.0	220	173	188	30.6	23.4	17.0	4.06	0.15	9.2	22.8	<0.01	<0.01	<0.01	<0.01	<0.02	<0.45	<0.01	<0.45	<0.03	0.11	7.95	5.39	13.4	0.80	0.01	0
	05/12/2019		7.35	20.9	97	75	74	16.6	8.1	2.0	5.64	0.25	5.5	13.0	0.40	<0.01	0.84	0.02	<0.02	0.47	<0.35	0.47	<0.03	0.14	78.20	6.91	12.1	1.20	<0.001	8
	16/01/2020		7.86	42.3	216	186	198	32.3	25.6	14.6	4.24	0.14	10.0	9.0	0.14	0.06	0.41	0.02	<0.02	0.47	<0.35	<0.45	<0.03	0.19	28.30	6.18	12.8	0.90	0.01	3
	06/02/2020		7.94	47.6	244	219	198	43.8	26.6	11.6	1.53	0.10	4.1	37.1	<0.01	<0.01	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.06	22.10	7.66	10.6	2.40	0.01	8
	09/03/2020		7.73	46.6	262	232	224	48.4	26.9	10.6	2.31	0.10	5.3	34.1	0.01	<0.01	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.16	7.66	6.40	9.0	1.00	0.00	0
	08/05/2020		7.93	52.8	298	264	238	55.1	30.7	10.3	5.97	<0.09	13.1	39.5	0.11	0.06	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.10	8.28	6.55	18.1	1.80	0.01	0
	19/05/2020		7.97	52.8	302	267	231	53.5	32.5	14.2	4.97	<0.09	10.6	44.7	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	0.75	0.75	<0.03	0.03	3.89	6.92	17.7	0.80	<0.001	10
	02/06/2020		7.92	50.8	292	256	229	50.8	31.3	14.6	4.17	<0.09	10.0	39.7	<0.01	0.03	<0.01	<0.01	<0.01	<0.45	0.85	0.85	<0.03	0.58	7.80	7.58	13.3	0.60	0.00	0
	07/07/2020		7.93	53.7	279	235	218	46.8	28.6	13.5	5.20	<0.09	11.8	39.9	0.01	<0.01	<0.01	<0.01	<0.01	<0.45	0.64	0.64	<0.03	0.26	4.40	7.51	15.9	5.00	0.02	64
	13/08/2020		7.99	47.8	238	216	232	44.1	25.6	11.8	2.61	<0.09	7.8	6.5	<0.01	0.10	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.16	7.51	7.49	11.9	0.83	0.01	4
	08/09/2020		8.15	48.2	252	223	242	46.2	26.1	12.4	2.96	0.16	9.6	7.8	0.01	0.01	<0.01	<0.01	0.02	<0.45	0.39	<0.45	<0.03	0.64	14.20	7.41	13.0	0.80	<0.01	0
	02/10/2020		7.93	47.5	255	219	231	41.1	28.3	18.4	4.02	0.09	9.9	14.1	<0.01	<0.01	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.62	14.30	7.21	13.7	0.67	0.01	18
LSW03	21/11/2019		8.50	26.9	129	113	92	23.2	13.5	4.0	1.06	<0.09	6.2	26.0	<0.01	<0.01	<0.01	<0.01	<0.02	<0.45	0.01	<0.45	<0.03	0.24	68.30	5.36	11.4	2.80	0.03	0
	05/12/2019		6.81	25.6	128	95	71	22.6	9.4	4.9	5.44	0.23	8.7	33.7	<0.01	<0.01	<0.01	0.01	<0.02	<0.45	<0.35	<0.45	0.16	0.59	48.40	6.12	22.5	1.20	0.02	12
	16/01/2020		7.77	35.8	176	141	113	27.2	17.8	9.3	3.71	0.22	11.5	38.2	0.04	0.02	<0.01	0.02	<0.02	<0.45	<0.35	<0.45	0.16	0.21	23.00	5.92	14.2	1.30	0.02	4
	06/02/2020		7.17	24.8	115	74	79	14.2	9.3	13.2	2.49	0.31	19.9	5.9	0.26	0.43	<0.01	<0.01	<0.02	1.07	<0.35	1.07	<0.03	0.05	220.00	7.44	28.2	0.80	0.02	80
	09/03/2020		7.42	39.6	211	179	145	36.9	21.0	9.2	1.87	0.12	12.1	42.9	<0.01	<0.01	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.31	3.49	6.86	11.2	2.00	0.01	4
	08/05/2020		7.41	41.2	227	190	140	41.8	20.9	10.3	1.73	<0.09	14.7	53.2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.44	3.91	6.80	16.3	1.20	0.03	0
	19/05/2020		7.40	43.6	249	209	149	40.2	26.3	12.4	1.82	<0.09	11.8	67.3	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.47	1.48	6.90	12.6	0.80	0.00	2
	02/06/2020		7.73	44.2	242	197	139	39.2	24.0	11.2	1.74	<0.09	13.0	69.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.50	2.30	7.64	10.7	1.20	0.01	0
	07/07/2020		8.18	34.7	178	131	111	20.9	19.2	15.0	4.90	<0.09	18.4	32.6	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.67	4.43	7.30	15.2	6.67	0.01	0
	13/08/2020		7.82	45.9	247	221	152	39.6	29.7	8.6	2.49	<0.09	12.5	63.3	0.03	0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.34	3.10	7.49	8.9	0.33	<0.001	2
	08/09/2020		8.15	40.9	219	185	142	36.8	22.5	12.5	3.64	0.26	17.7	40.5	0.02	<0.01	<0.01	0.01	0.02	<0.45	<0.35	<0.45	<0.03	0.95	4.82	7.58	16.3	2.00	0.01	0
	02/10/2020		7.54	48.9	245	204	159	40.3	25.2	10.3	1.81	<0.09	13.1	59.1	<0.01	<0.01	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.30	3.67	7.38	11.6	0.80	<0.001	4

Exxaro Leeuwpan																														
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Boron (B)	Hexavalent Chromium (Cr^{6})	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Total Inorganic Nitrogen (mg/l)	Ortho Phosphate as P (mg/l)	Total Phospahte	Turbidity	Dissolved Oxygen (DO)	Dissolved Organic Carbon (DOC)	Oil & Grease	Chlorofyll-a	*Escherichia coli* (*E.coli*)
DWAF Domestic Target Water Quality Range			6.0 - 9.0	70	450	-	-	32	30	100	50	1	100	200	0.1	0.05	0.15	-	0.050	1	6	-	-	-	1	-	5	-	1	0
Surface Water																														
LSW05	20/11/2019		7.82	48.9	239	217	192	37.8	29.7	9.9	2.88	0.19	14.5	29	<0.01	0.05	<0.01	0.01	<0.02	<0.45	<0.01	<0.45	<0.03	0.13	3.2	5.53	18.5	2.80	<0.001	0
	05/12/2019		7.38	47.4	254	220	161	48.0	24.3	7.5	5.54	0.19	10.7	61	<0.01	<0.01	<0.01	0.03	<0.02	<0.45	<0.35	<0.45	<0.03	0.06	3.7	6.80	19.3	0.80	<0.001	20
	16/01/2020		7.67	50.9	267	225	180	42.2	29.0	11.7	5.35	0.18	18.3	52	0.07	0.03	0.19	0.02	<0.02	<0.45	<0.35	<0.45	<0.03	0.10	9.0	6.18	15.1	1.10	0.02	12
	06/02/2020		7.45	35.4	167	142	141	29.5	16.7	9.2	1.70	0.21	13.6	12	0.04	0.22	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.05	12.4	7.21	20.2	1.20	0.00	36
	09/03/2020		7.39	43.3	223	186	156	38.4	21.8	11.8	4.89	0.20	17.8	34	<0.01	0.03	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	0.14	0.50	5.7	6.47	17.4	1.20	0.01	2
	08/05/2020		7.56	41.1	220	187	128	40.0	21.1	8.6	4.45	<0.09	16.4	53	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.29	56.3	6.29	13.6	1.60	<0.001	22
	19/05/2020		7.70	42.2	248	203	152	40.4	24.8	12.1	3.76	<0.09	13.0	63	<0.01	<0.01	0.02	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.19	2.1	6.38	13.9	0.80	<0.001	44
	02/06/2020		7.93	43.3	244	198	136	39.4	24.2	11.0	2.54	<0.09	12.9	73	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.75	6.4	7.73	9.9	1.00	0.00	0
	07/07/2020		8.01	45.2	243	196	139	40.5	23.0	9.9	3.60	<0.09	14.8	68	0.04	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.30	16.1	7.53	8.9	2.78	0.02	6
	13/08/2020		7.99	45.7	245	197	158	40.2	23.4	10.2	3.79	<0.09	13.5	59	0.10	0.01	0.04	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.55	16.6	7.66	10.1	0.33	<0.001	0
	08/09/2020		8.03	48.5	264	216	189	43.1	26.4	12.5	4.91	0.13	17.1	46	0.03	<0.01	<0.01	0.02	0.02	<0.45	<0.35	<0.45	<0.03	0.27	12.8	7.70	14.1	1.20	<0.01	0
	02/10/2020		7.90	47.0	247	218	192	38.3	29.6	12.2	3.62	0.12	9.0	39	<0.01	<0.01	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.50	5.6	7.21	14.9	0.40	0.01	0
LSW06	21/11/2019	Dry																												
	05/12/2019	Dry																												
	16/01/2020	Dry																												
	06/02/2020	Dry																												
	09/03/2020	Dry																												
	08/05/2020	Dry																												
	19/05/2020	Dry																												
	02/06/2020	Dry																												
	07/07/2020	Dry																												
	13/08/2020	Dry																												
	07/09/2020	Dry																												
	02/10/2020	Dry																												

Exxaro Leeuwpan																													
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Boron (B)	Hexavalent Chromium (Cr^6)	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Total Inorganic Nitrogen (mg/l)	Ortho Phosphate as P (mg/l)	Total Phospahte	Turbidity	Dissolved Oxygen (DO)	Dissolved Organic Carbon (DOC)	Oil & Grease	Chlorofyll-a	*Escherichia coli* (*E.coli*)
DWAF Domestic Target Water Quality Range			6.0 - 9.0	70	450	-	-	32	30	100	50	1	100	200	0.1	0.05	0.15	-	0.050	1	6	-	-	-	1	-	5	-	1	0
Surface Water																													
LSW07	21/11/2019	Dry																											
	05/12/2019	Dry																											
	16/01/2020	Dry																											
	06/02/2020	Dry																											
	09/03/2020	Dry																											
	08/05/2020	Dry																											
	19/05/2020	Dry																											
	02/06/2020	Dry																											
	07/07/2020	Dry																											
	13/08/2020	Dry																											
	07/09/2020	Dry																											
	02/10/2020	Dry																											
LSW08	21/11/2019	Dry																											
	05/12/2019	Dry																											
	16/01/2020	Dry																											
	06/02/2020	Dry																											
	09/03/2020	Dry																											
	08/05/2020	Dry																											
	19/05/2020	Dry																											
	02/06/2020	Dry																											
	07/07/2020	Dry																											
	13/08/2020	Dry																											
	07/09/2020	Dry																											
	02/10/2020	Dry																											

Exxaro Leeuwpan																														
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Boron (B)	Hexavalent Chromium (Cr^6)	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Total Inorganic Nitrogen (mg/l)	Ortho Phosphate as P (mg/l)	Total Phospahte	Turbidity	Dissolved Oxygen (DO)	Dissolved Organic Carbon (DOC)	Oil & Grease	Chlorofyll-a	*Escherichia coli* (*E.coli*)
DWAF Domestic Target Water Quality Range			6.0 - 9.0	70	450	-	-	32	30	100	50	1	100	200	0.1	0.05	0.15	-	0.050	1	6	-	-	-	1	-	5	-	1	0
Surface Water																														
LSW12	21/11/2019	No Access																												
	05/12/2019	Dry																												
	16/01/2020	Dry																												
	06/02/2020	Dry																												
	09/03/2020	Dry																												
	08/05/2020	Dry																												
	19/05/2020	Dry																												
	02/06/2020	Dry																												
	07/07/2020	Dry																												
	13/08/2020	Dry																												
	07/09/2020	Dry																												
	02/10/2020	Dry																												
LSW13	21/11/2019		6.80	47	301	199	11	43.2	22.1	1.3	7.11	0.20	3.6	207	0.18	1.30	0.56	0.01	<0.02	1.95	0.02	3	0.24	0.39	33.8	5.41	6.40	0.80	<0.001	14
	05/12/2019		6.93	78	545	404	19	89.5	43.9	5.8	8.86	0.16	14.7	368	<0.01	<0.01	<0.01	0.04	<0.02	<0.45	0.46	0.48	<0.03	<0.03	18.5	6.42	12.50	1.20	<0.001	0
	16/01/2020		7.10	168	1436	1011	34	186.0	133.0	29.6	11.80	0.25	15.3	1032	0.08	0.45	0.48	0.09	<0.02	1.95	0.75	0.77	0.24	0.25	54.9	6.12	11.10	1.80	0.01	0
	06/02/2020		7.60	29	155	121	33	26.6	13.2	1.8	1.52	0.27	1.5	91	<0.01	<0.01	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.05	19.5	7.64	5.25	2.40	<0.001	2
	09/03/2020		7.22	53	329	246	41	48.0	30.7	6.9	3.02	0.14	17.6	198	<0.01	0.01	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.15	8.1	6.42	5.52	1.50	0.01	2
	08/05/2020		7.17	43	283	203	38	41.8	23.9	5.0	5.89	<0.09	11.7	172	<0.01	0.22	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.32	21.8	6.30	16.20	1.20	0.03	0
	19/05/2020		7.29	44	285	207	39	37.7	27.4	9.0	5.98	<0.09	12.9	169	<0.01	0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.10	15.5	6.19	8.80	1.00	<0.001	0
	02/06/2020		7.65	46	291	208	37	39.4	26.5	8.4	5.24	<0.09	15.1	174	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.98	12.2	7.63	6.52	1.00	<0.001	0
	07/07/2020		7.86	47	302	210	34	38.9	27.5	8.6	4.06	<0.09	14.4	186	0.01	<0.01	<0.01	<0.01	<0.01	<0.45	0.40	<0.45	<0.03	0.98	108.0	7.48	5.12	1.33	0.00	0
	13/08/2020		7.47	48	292	215	31	36.5	30.1	6.5	4.07	0.13	15.7	180	0.01	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.16	11.0	7.70	5.68	1.50	<0.001	6
	08/09/2020		7.36	53	343	243	30	40.7	34.4	9.1	4.04	0.15	18.0	218	0.09	0.22	0.04	<0.01	0.02	<0.45	<0.35	<0.45	<0.03	0.48	7.1	7.68	6.94	3.00	0.01	0
	02/10/2020		7.42	58	373	257	39	42.5	36.6	11.6	4.61	0.20	20.6	230	0.04	0.16	<0.01	<0.01	<0.02	0.62	0.42	1.05	<0.03	0.78	28.1	7.68	6.24	0.57	<0.001	6

Exxaro Leeuwpan																														
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Boron (B)	Hexavalent Chromium (Cr^6)	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Total Inorganic Nitrogen (mg/l)	Ortho Phosphate as P (mg/l)	Total Phospahte	Turbidity	Dissolved Oxygen (DO)	Dissolved Organic Carbon (DOC)	Oil & Grease	Chlorofyll-a	*Escherichia coli* (*E.coli*)
DWAF Domestic Target Water Quality Range			6.0 - 9.0	70	450	-	-	32	30	100	50	1	100	200	0.1	0.05	0.15	-	0.050	1	6	-	-	-	1	-	5	-	1	0
Surface Water																														
RD1	21/11/2019		7.49	42	197	167	157	33.6	20.3	9.1	3.81	0.17	12.7	23	0.08	0.07	<0.01	<0.01	<0.02	<0.45	<0.01	<0.45	0.06	0.17	14.3	5.76	19.30	0.80	0.00	6
	05/12/2019		7.42	42	226	194	136	43.1	20.9	6.8	5.56	0.18	11.5	54	<0.01	<0.01	<0.01	0.02	<0.02	<0.45	0.41	<0.45	0.06	0.14	40.8	6.91	20.00	1.60	<0.001	0
	16/01/2020		7.46	42	205	190	146	37.6	23.3	8.3	4.69	0.16	12.5	37	0.08	0.07	<0.01	0.02	<0.02	<0.45	0.41	<0.45	0.06	0.16	25.8	6.28	18.50	0.70	<0.001	0
	06/02/2020	Dry																												
	09/03/2020	Dry																												
	08/05/2020	Dry																												
	19/05/2020	Dry																												
	02/06/2020	Dry																												
	07/07/2020	Dry																												
	13/08/2020	Dry																												
	07/09/2020	Dry																												
	02/10/2020	Dry																												
Comparrison Samples																														
LSW03 A	08/05/2020		7.38	41	217	180	136	38.0	20.7	9.9	2.10	<0.09	14.2	51	0.01	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.36	4.7	6.61	14.90	0.40	0.01	0
	07/07/2020		8.10	35	177	127	111	20.5	18.4	13.8	4.50	<0.09	19.0	34	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.41	3.9	7.29	14.70	5.56	0.01	0
	13/08/2020		7.79	47	249	216	153	39.4	28.6	8.7	3.46	<0.09	12.6	64	0.02	0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.20	1.5	7.67	8.64	23.00	0.00	0
	08/09/2020		8.03	41	222	186	140	37.1	22.6	12.6	3.70	0.22	18.0	44	<0.01	<0.01	<0.01	0.01	0.02	<0.45	<0.35	<0.45	<0.03	0.37	7.3	7.69	16.10	1.00	0.01	0
	02/10/2020		7.46	46	245	204	158	40.0	25.3	10.2	1.79	<0.09	15.7	57	<0.01	<0.01	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.53	3.9	7.68	11.48	0.40	0.02	2

Exxaro Leeuwpan																														
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Boron (B)	Hexavalent Chromium (Cr^{6})	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Total Inorganic Nitrogen (mg/l)	Ortho Phosphate as P (mg/l)	Total Phospahte	Turbidity	Dissolved Oxygen (DO)	Dissolved Organic Carbon (DOC)	Oil & Grease	Chlorofyll-a	*Escherichia coli* (*E.coli*)
DWAF Domestic Target Water Quality Range			6.0 - 9.0	70	450	-	-	32	30	100	50	1	100	200	0.1	0.05	0.15	-	0.050	1	6	-	-	-	1	-	5	-	1	0
Surface Water																														
LSW05 A	21/11/2019		7.83	51.5	245	218	201	43.9	26.4	9.7	2.84	0.21	13.9	27	<0.01	0.04	<0.01	<0.01	<0.02	<0.45	<0.01	<0.45	<0.03	0.14	2.7	5.66	15.7	0.80	0.02	4
	05/12/2019		7.55	46.4	245	219	153	47.5	24.4	7.4	5.59	0.18	10.5	57	<0.01	<0.01	<0.01	0.03	<0.02	<0.45	<0.35	<0.45	<0.03	0.05	4.1	6.78	19.2	3.60	<0.001	30
	16/01/2020		7.69	50.6	266	231	174	45.6	28.5	10.5	5.57	0.17	18.2	53	0.01	0.03	<0.01	0.03	<0.02	<0.45	<0.35	<0.45	<0.03	0.13	6.6	6.57	14.7	1.20	0.02	13
	06/02/2020		7.55	35.1	172	147	146	30.5	17.1	9.2	1.70	0.22	13.6	12	0.04	0.21	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.04	7.3	7.53	20.8	1.20	0.00	68
	09/03/2020		7.49	43.0	230	186	163	38.4	21.9	11.8	4.70	0.21	17.7	37	<0.01	0.03	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	0.12	0.51	5.3	6.97	18.2	1.00	<0.001	4
	08/05/2020		7.62	41.2	222	186	127	40.0	20.8	8.6	4.44	<0.09	16.4	53	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	0.64	<0.45	<0.03	0.49	56.3	6.77	14.2	1.60	0.01	30
	19/05/2020		7.75	42.3	244	204	138	40.7	24.9	12.0	3.79	<0.09	13.2	66	<0.01	0.03	0.02	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.28	2.1	6.82	13.4	1.00	0.01	46
	02/06/2020		7.91	43.7	247	201	135	39.8	24.7	11.1	2.52	<0.09	13.6	75	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.67	2.9	7.70	10.0	1.20	0.00	0
	07/07/2020		7.99	45.2	243	194	140	40.1	22.8	10.0	3.55	<0.09	14.9	68	0.03	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.27	13.0	7.51	5.5	5.00	0.05	10
	13/08/2020		7.99	45.1	242	193	153	40.4	22.3	10.3	3.83	0.14	13.6	59	0.08	0.01	0.02	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.17	10.1	7.38	10.2	0.33	<0.001	2
	08/09/2020		8.08	48.4	262	217	188	43.2	26.4	12.7	4.98	0.10	15.1	46	0.03	<0.01	<0.01	0.02	0.02	<0.45	<0.35	<0.45	<0.03	0.21	11.4	7.38	13.6	1.60	0.01	0
	02/10/2020		7.94	49.8	247	218	193	38.4	29.7	12.2	3.60	0.12	9.1	38	<0.01	<0.01	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.26	5.8	7.58	15.0	0.40	<0.001	14
WP01 A	19/05/2020		7.60	52.2	307	250	189	44.7	33.5	14.3	7.44	<0.09	12.6	81	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.06	4.6	6.61	19.4	0.60	<0.001	32
	02/06/2020		7.86	52.5	303	251	183	45.8	33.2	14.9	7.14	<0.09	12.6	79	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.71	17.4	7.44	17.0	0.60	0.00	0
	07/07/2020		8.27	56.9	289	258	262	51.6	31.4	11.2	7.02	<0.09	13.6	17	0.03	0.02	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.15	10.6	7.74	19.8	6.67	0.01	0
LSW13 A	12/09/2019		7.05	220	1945	1342	39	244.0	178.0	43.1	13.80	0.28	16.4	1426	0.07	0.01	0.06	0.08	<0.02	<0.45	<0.35	<0.45	<0.03	0.61	330.0	6.33	11.00	1.20	0.02	0
WP 02 A	21/11/2019		7.76	43.9	221	187	182	37.8	22.4	13.1	4.09	0.17	9.5	24.7	<0.01	<0.01	<0.01	<0.01	<0.02	<0.45	<0.01	<0.45	<0.03	0.12	8.07	5.48	13.2	0.80	<0.001	0
	05/12/2019		7.21	20	96	72	76	16.1	7.8	1.9	5.68	0.29	4.9	11	0.96	<0.01	1.89	0.02	<0.02	<0.45	<0.35	<0.45	<0.03	0.55	78.0	7.02	12.60	2.00	<0.001	26
	16/01/2020		7.71	41	211	185	190	33.3	24.8	11.2	4.43	0.15	9.1	13	0.52	0.10	0.88	0.02	<0.02	<0.45	<0.35	<0.45	<0.03	0.18	24.2	6.26	11.70	1.10	0.01	12
	06/02/2020		7.95	48	243	215	206	42.9	26.1	11.8	1.55	0.14	3.9	33	<0.01	<0.01	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.07	44.7	7.73	10.90	3.20	0.08	8
	09/03/2020		7.71	46	236	223	222	48.5	24.7	10.8	2.28	0.09	5.2	12	0.01	<0.01	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.13	7.1	6.33	9.32	1.20	0.01	0
	08/05/2020		8.00	54	295	271	233	59.0	30.0	10.1	5.99	<0.09	15.2	33	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	0.39	<0.45	<0.03	0.03	4.7	6.41	19.10	0.80	<0.001	6
	19/05/2020		7.92	55	287	257	235	53.4	30.0	13.0	4.80	<0.09	10.0	34	0.08	<0.01	0.03	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.08	4.2	6.46	17.50	0.80	0.01	2
	02/06/2020		7.80	53	286	256	235	50.9	31.4	12.3	5.29	<0.09	11.1	31	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	0.74	<0.45	<0.03	0.43	8.7	7.65	13.10	0.80	<0.001	0
	07/07/2020		7.57	54	282	236	218	47.0	28.8	13.5	5.20	<0.09	12.3	41	0.02	0.01	<0.01	<0.01	<0.01	<0.45	0.62	0.62	<0.03	0.17	2.3	7.38	16.30	3.33	0.02	60
	08/09/2020		8.52	47	243	223	228	45.9	26.2	12.6	3.01	0.15	9.5	7	0.01	0.02	<0.01	<0.01	0.02	<0.45	0.39	<0.45	<0.03	0.22	14.3	7.38	12.90	1.40	0.01	0
	02/10/2020		7.93	47	246	210	229	38.6	27.5	16.3	3.99	0.09	9.9	11	0.01	<0.01	<0.01	<0.01	<0.02	<0.45	0.36	<0.45	<0.03	0.39	2.3	7.58	13.62	0.80	<0.001	28

Table 5: Process Water Sample Results

Exxaro Leeuwpan																															
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Boron (B)	Hexavalent Chromium (Cr^{6})	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Total Inorganic Nitrogen (mg/l)	Ortho Phosphate as P (mg/l)	Total Phosphate	Turbidity	Dissolved Oxygen (DO)	Dissolved Organic Carbon (DOC)	Oil & Grease	Chlorofyll-a	Escherichia coli (E.coli)
WUL Limit			5.0 - 10.0	750	3800	-	-	-	300	500	40	5	500	3200	20	10	10	-	5	10	20	15	10	20	-	-	100	1000	0.15	10
General Authorisation Limits			5.5-9.5	150	-	-	-	-	-	-	-	1	-	-	0.3	0.1	-	-	0.05	6	15	-	10	-	-	-	-	2.5	-	-
Process Water																															
KR01A	21/11/2019		7.90	343	3510	2590	122	630	247	46.6	11.1	<0.09	13.8	2488	0.10	0.12	<0.01	0.08	<0.02	<0.45	<0.01	<0.45	<0.03	0.05	12.2	5.28	8.12	0.80	0.05	4
	05/12/2019		7.91	338	3356	2622	113	608	268	50.6	11.7	<0.09	14.5	2335	<0.01	<0.01	<0.01	0.13	<0.02	<0.45	<0.35	<0.45	<0.03	<0.03	14.6	6.81	5.17	2.40	<0.001	20
	16/01/2020		7.91	340	3304	2498	152	598	244	50.4	12.5	<0.09	16.8	2290	0.08	0.15	0.15	0.09	<0.02	<0.45	<0.35	<0.45	<0.03	0.06	21.5	6.22	6.07	1.40	0.02	5
	06/02/2020		7.75	259	2432	1700	51	463	132	41.9	8.2	0.14	12.8	1697	0.24	0.18	0.15	<0.01	<0.02	0.60	9.42	11.00	<0.03	0.05	5.6	7.49	4.68	6.40	<0.001	6
	10/03/2020		7.60	263	2519	1920	73	482	174	36.9	9.7	<0.09	12.6	1738	0.01	0.04	<0.01	<0.01	<0.02	<0.45	4.70	4.83	<0.03	0.17	3.8	6.48	2.71	1.75	<0.001	4
	08/05/2020		7.56	260	2522	1892	100	474	172	39.8	11.7	<0.09	14.1	1733	0.09	0.02	<0.01	<0.01	0.03	<0.45	3.92	3.92	<0.03	0.05	11.1	6.38	9.90	1.40	<0.001	8
	19/05/2020		7.27	251	2402	1816	116	452	167	47.0	12.0	<0.09	12.0	1608	0.03	0.04	<0.01	0.02	<0.01	<0.45	7.58	7.79	<0.03	0.06	3.2	6.34	9.22	1.60	0.01	0
	02/06/2020		7.98	262	2565	1872	119	466	172	46.7	10.9	<0.09	12.8	1755	0.10	0.43	<0.01	0.03	<0.01	<0.45	6.68	6.82	<0.03	0.23	2.3	7.63	6.58	1.40	<0.001	0
	07/07/2020		7.97	269	2514	1845	127	455	172	40.4	11.5	<0.09	12.4	1722	0.35	0.58	<0.01	0.06	0.03	<0.45	5.10	5.22	<0.03	0.15	2.1	7.60	5.04	0.67	0.01	0
	13/08/2020		7.91	257	2560	1915	130	475	177	45.0	12.3	<0.09	12.3	1728	<0.01	0.29	<0.01	<0.01	<0.01	0.77	7.00	7.93	<0.03	0.22	2.0	7.68	6.40	2.50	<0.001	0
	09/09/2020		8.22	275	2627	1867	129	484	160	43.0	12.3	<0.09	15.8	1812	0.02	0.54	<0.01	0.14	0.03	0.71	4.69	5.59	<0.03	0.13	14.7	7.21	7.48	6.00	0.01	18
	02/10/2020		7.93	277	2675	1929	121	461	189	51.9	13.8	<0.09	17.9	1846	<0.01	0.48	<0.01	0.15	<0.02	0.76	4.57	5.55	<0.03	0.92	1.8	7.40	7.12	0.40	0.00	2
KR03	21/11/2019	No Stream																													
	05/12/2019	No Stream																													
	16/01/2020	No Stream																													
	06/02/2020	No Stream																													
	09/03/2020	No Stream																													
	08/05/2020	No Stream																													
	19/05/2020	No Stream																													
	02/06/2020	No Stream																													
	07/07/2020	No Stream																													
	13/08/2020	No Stream																													
	07/09/2020	No Stream																													
	02/10/2020	No Stream																													

Exxaro Leeuwpan																														
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Boron (B)	Hexavalent Chromium (Cr^{6})	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Total Inorganic Nitrogen (mg/l)	Ortho Phosphate as P (mg/l)	Total Phosphate	Turbidity	Dissolved Oxygen (DO)	Dissolved Organic Carbon (DOC)	Oil & Grease	Chlorofyl-a	Escherichia coli (E.coli)
WUL Limit			5.0 - 10.0	750	3800	-	-	-	300	500	40	5	500	3200	20	10	10	-	5	10	20	15	10	20	-	-	100	1000	0.15	10
General Authorisation Limits			5.5-9.5	150	-	-	-	-	-	-	-	1	-	-	0.3	0.1	-	-	0.05	6	15	-	10	-	-	-	-	2.5	-	-
Process Water																														
KR04	21/11/2019	Dry																												
	05/12/2019	Dry																												
	16/01/2020	Dry																												
	06/02/2020	Dry																												
	09/03/2020	Dry																												
	08/05/2020	Dry																												
	19/05/2020	Dry																												
	02/06/2020	Dry																												
	07/07/2020	Dry																												
	13/08/2020	Dry																												
	07/09/2020	Dry																												
	02/10/2020	Dry																												
LSW09	21/11/2019		8.48	88	522	396	35	104	33	5.2	2.4	<0.09	3.5	345	0.17	0.03	0.45	0.05	<0.02	<0.45	0.09	1.51	<0.03	0.07	53.60	5.84	16.35	0.80	<0.001	8
	05/12/2019		7.63	144	1156	880	40	237	70	16.9	5.5	0.15	10.7	778	<0.01	<0.01	0.05	0.09	<0.02	0.51	2.86	3.54	<0.03	0.13	36.40	7.10	12.80	3.20	<0.001	2
	16/01/2020		7.89	238	2129	1545	74	363	155	35.6	11.8	0.16	14.1	1482	0.58	0.03	0.21	0.10	<0.02	0.51	4.43	4.85	<0.03	0.10	83.00	5.94	8.96	1.00	0.01	1
	06/02/2020		6.93	221	1919	1358	33	336	126	40.3	8.4	0.20	16.3	1348	0.02	0.09	<0.01	0.07	<0.02	0.53	5.25	5.82	<0.03	0.06	139.00	7.38	43.50	3.20	1.34	110
	10/03/2020		7.73	229	2011	1432	71	341	141	41.4	12.3	<0.09	14.5	1373	0.02	0.11	<0.01	<0.01	<0.02	0.57	9.82	10.68	<0.03	0.27	14.30	6.39	3.88	1.50	<0.001	8
	08/05/2020		7.85	208	1866	1295	70	309	127	35.8	9.9	<0.09	13.7	1287	0.04	0.06	<0.01	<0.01	0.02	0.47	8.98	9.93	<0.03	0.48	9.73	6.28	8.24	1.20	<0.001	38
	19/05/2020		7.86	226	2002	1402	76	337	136	47.7	13.9	<0.09	14.8	1366	<0.01	0.13	0.04	0.08	<0.01	1.15	8.66	9.81	<0.03	0.13	7.94	6.25	7.82	1.20	<0.001	42
	02/06/2020		7.76	172	1538	1085	77	268	101	33.4	8.9	<0.09	14.7	1036	0.25	0.05	<0.01	0.03	<0.01	0.61	6.53	7.31	<0.03	0.55	4.59	7.71	7.84	0.80	<0.001	0
	07/07/2020		8.06	261	2396	1719	89	413	167	42.1	11.8	<0.09	14.2	1663	0.35	0.20	<0.01	0.08	0.03	0.52	6.62	7.29	<0.03	0.17	7.33	7.57	5.44	1.17	0.02	0
	13/08/2020		7.77	289	2783	1958	76	441	208	49.7	14.5	<0.09	15.9	1956	<0.01	0.04	<0.01	<0.01	<0.01	<0.45	11.60	11.7	<0.03	0.15	26.30	7.53	5.66	3.80	0.01	10
	09/09/2020		7.67	269	2536	1815	89	420	186	45.2	13.5	<0.09	16.7	1763	0.02	0.22	<0.01	0.19	0.03	1.46	7.89	9.71	<0.03	0.28	15.00	7.54	6.72	1.80	0.01	4
	02/10/2020		7.86	280	2737	1977	84	457	203	57.8	16.6	<0.09	18.0	1904	<0.01	0.20	<0.01	0.18	<0.02	1.65	6.15	8.25	<0.03	0.23	123.00	7.39	3.02	0.80	0.00	6

Exxaro Leeuwpan																														
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Boron (B)	Hexavalent Chromium (Cr^{6})	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Total Inorganic Nitrogen (mg/l)	Ortho Phosphate as P (mg/l)	Total Phosphate	Turbidity	Dissolved Oxygen (DO)	Dissolved Organic Carbon (DOC)	Oil & Grease	Chlorofyl-a	Escherichia coli (E.coli)
WUL Limit			5.0 - 10.0	750	3800	-	-	-	300	500	40	5	500	3200	20	10	10	-	5	10	20	15	10	20	-	-	100	1000	0.15	10
General Authorisation Limits			5.5-9.5	150	-	-	-	-	-	-	-	1	-	-	0.3	0.1	-	-	0.05	6	15	-	10	-	-	-	-	2.5	-	-
Process Water																														
ODN_PIT	21/11/2019		7.91	297	2796	2037	63.6	509	186	43.5	13.1	<0.09	14.0	1950	0.08	0.16	0.04	0.10	<0.02	0.78	0.9	10.22	<0.03	0.06	17.90	5.61	3.11	4.00	<0.001	2
	05/12/2019		7.70	283	2683	1968	54.0	471	192	50.4	14.0	0.13	18.7	1860	<0.01	0.34	<0.01	0.08	<0.02	0.65	9.1	10.5	<0.03	<0.03	13.20	7.07	2.99	2.40	0.00	0
	16/01/2020		7.82	296	2758	2006	64.6	480	196	49.5	14.1	0.15	17.2	1915	0.08	0.21	0.04	0.09	0.02	0.76	9.4	10.4	<0.03	0.10	18.60	6.17	3.89	1.33	0.03	0
	06/02/2020		7.57	259	2407	1770	50.0	430	169	39.1	7.2	0.15	13.5	1672	0.05	0.17	<0.01	<0.01	<0.02	0.60	9.5	11.1	<0.03	0.06	28.60	7.11	4.68	3.20	0.00	18
	09/03/2020		7.30	255	2412	1747	49.0	429	164	42.5	12.5	<0.09	13.9	1667	<0.01	0.18	<0.01	<0.01	<0.02	0.49	11.2	12.68	<0.03	0.13	3.89	6.54	2.41	0.80	<0.001	6
	08/05/2020		7.75	253	2417	1680	49.8	404	163	43.4	12.6	<0.09	15.5	1694	0.02	0.18	<0.01	0.04	0.01	1.07	11.0	13.3	<0.03	0.25	7.26	6.44	7.16	0.60	0.01	0
	19/05/2020		7.23	256	2364	1743	50.6	431	162	45.3	14.6	<0.09	14.0	1612	0.02	0.13	<0.01	0.04	0.01	1.36	11.5	13.5	<0.03	0.12	9.45	6.88	7.04	1.80	<0.001	8
	02/06/2020		7.68	257	2460	1756	53.6	436	162	49.9	13.5	<0.09	14.3	1697	0.15	0.16	<0.01	0.05	<0.01	1.30	11.9	13.8	<0.03	0.34	18.70	7.52	5.90	1.40	<0.001	2
	07/07/2020		7.82	257	2390	1662	61.8	395	164	42.2	12.1	<0.09	14.1	1678	0.69	0.26	<0.01	0.08	0.07	0.95	10.2	11.6	<0.03	0.16	3.63	7.64	2.77	5.00	0.01	0
	13/08/2020		7.66	259	2399	1717	68.2	394	178	41.7	14.3	<0.09	14.1	1653	<0.01	0.43	<0.01	<0.01	<0.01	1.80	13.6	15.8	<0.03	0.13	5.53	7.21	4.42	0.50	0.00	0
	09/09/2020		7.88	264	2439	1676	69.6	409	159	44.7	14.0	<0.09	16.1	1706	0.02	0.27	<0.01	0.17	0.03	1.87	10.2	12.6	<0.03	0.08	17.90	7.54	5.78	0.60	0.00	0
	02/10/2020		7.96	272	2610	1867	71.2	438	188	52.4	16.1	<0.09	16.8	1806	<0.01	0.21	<0.01	0.13	<0.02	2.62	10.5	13.92	<0.03	0.66	10.30	7.33	4.24	0.27	<0.001	56
OG_PIT	21/11/2019	Rehabilitated																												
	05/12/2019	Rehabilitated																												
	16/01/2020	Rehabilitated																												
	06/02/2020	Rehabilitated																												
	09/03/2020	Rehabilitated																												
	08/05/2020	Rehabilitated																												
	19/05/2020	Rehabilitated																												
	02/06/2020	Rehabilitated																												
	07/07/2020	Rehabilitated																												
	13/08/2020	Rehabilitated																												
	09/09/2020	Rehabilitated																												
	02/10/2020	Rehabilitated																												

Exxaro Leeuwpan																														
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Boron (B)	Hexavalent Chromium (Cr^{6})	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Total Inorganic Nitrogen (mg/l)	Ortho Phosphate as P (mg/l)	Total Phosphate	Turbidity	Dissolved Oxygen (DO)	Dissolved Organic Carbon (DOC)	Oil & Grease	Chlorofyl-a	Escherichia coli (E.coli)
WUL Limit			5.0 - 10.0	750	3800	-	-	-	300	500	40	5	500	3200	20	10	10	-	5	10	20	15	10	20	-	-	100	1000	0.15	10
General Authorisation Limits			5.5-9.5	150	-	-	-	-	-	-	-	1	-	-	0.3	0.1	-	-	0.05	6	15	-	10	-	-	-	-	2.5	-	-
Process Water																														
OH_PIT	21/11/2019	Rehabilitated																												
	05/12/2019	Rehabilitated																												
	16/01/2020	Rehabilitated																												
	06/02/2020	Rehabilitated																												
	09/03/2020	Rehabilitated																												
	08/05/2020	Rehabilitated																												
	19/05/2020	Rehabilitated																												
	02/06/2020	Rehabilitated																												
	07/07/2020	Rehabilitated																												
	13/08/2020	Rehabilitated																												
	09/09/2020	Rehabilitated																												
	02/10/2020	Rehabilitated																												
OJ_PIT	21/11/2019	Rehabilitated																												
	05/12/2019	Rehabilitated																												
	16/01/2020	Rehabilitated																												
	06/02/2020	Rehabilitated																												
	09/03/2020	Rehabilitated																												
	08/05/2020	Rehabilitated																												
	19/05/2020	Rehabilitated																												
	02/06/2020	Rehabilitated																												
	07/07/2020	Rehabilitated																												
	13/08/2020	Rehabilitated																												
	09/09/2020	Rehabilitated																												
	02/10/2020	Rehabilitated																												

Exxaro Leeuwpan																														
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Boron (B)	Hexavalent Chromium (Cr^{6})	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Total Inorganic Nitrogen (mg/l)	Ortho Phosphate as P (mg/l)	Total Phosphate	Turbidity	Dissolved Oxygen (DO)	Dissolved Organic Carbon (DOC)	Oil & Grease	Chlorofyl-a	Escherichia coli (E.coli)
WUL Limit			5.0 - 10.0	750	3800	-	-	-	300	500	40	5	500	3200	20	10	10	-	5	10	20	15	10	20	-	-	100	1000	0.15	10
General Authorisation Limits			5.5-9.5	150	-	-	-	-	-	-	-	1	-	-	0.3	0.1	-	-	0.05	6	15	-	10	-	-	-	-	2.5	-	-
Process Water																														
OM_PIT	21/11/2019	Rehabilitated																												
	05/12/2019	Rehabilitated																												
	16/01/2020	Rehabilitated																												
	06/02/2020	Rehabilitated																												
	09/03/2020	Rehabilitated																												
	08/05/2020	Rehabilitated																												
	19/05/2020	Rehabilitated																												
	02/06/2020	Rehabilitated																												
	07/07/2020	Rehabilitated																												
	13/08/2020	Rehabilitated																												
	09/09/2020	Rehabilitated																												
	02/10/2020	Rehabilitated																												
OWM_PIT	21/11/2019		8.11	77.1	472	324	18	64.4	39.7	13.4	2.74	0.21	2.40	336	0.24	0.05	0.37	0.01	<0.02	<0.45	<0.01	<0.45	<0.03	0.05	35.10	5.71	6.00	3.60	<0.001	8
	05/12/2019		8.17	84.1	596	417	39	113.0	32.9	22.7	3.05	0.28	11.20	374	<0.01	<0.01	<0.01	0.08	<0.02	<0.45	3.49	3.53	<0.03	<0.03	37.20	7.00	5.17	2.80	0.00	0
	16/01/2020		7.99	95.7	622	426	67	82.4	53.4	32.8	3.06	0.32	4.92	396	0.13	0.05	0.20	0.03	<0.02	<0.45	1.93	1.98	<0.03	0.11	22.60	6.16	7.93	1.20	0.01	0
	06/02/2020		7.64	29.0	159	124	32	27.4	13.5	1.6	1.51	0.20	1.61	94	<0.01	<0.01	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.04	34.60	7.24	5.04	1.20	<0.001	0
	09/03/2020		7.84	29.7	154	121	24	26.1	13.5	1.6	1.71	0.24	1.73	95	0.06	<0.01	0.09	<0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.19	21.40	6.55	4.53	1.75	<0.001	14
	08/05/2020		7.23	23.9	151	108	29	23.8	11.8	3.2	3.25	0.10	5.80	85	0.02	0.07	<0.01	<0.01	0.02	<0.45	<0.35	<0.45	<0.03	0.98	1000.00	6.79	20.40	2.00	0.03	1500
	19/05/2020	Dry																												
	02/06/2020	Dry																												
	07/07/2020	Dry																												
	13/08/2020	Dry																												
	09/09/2020	Dry																												
	02/10/2020	Dry																												

Exxaro Leeuwpan																														
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Boron (B)	Hexavalent Chromium (Cr^{6})	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Total Inorganic Nitrogen (mg/l)	Ortho Phosphate as P (mg/l)	Total Phosphate	Turbidity	Dissolved Oxygen (DO)	Dissolved Organic Carbon (DOC)	Oil & Grease	Chlorofyl-a	Escherichia coli (E.coli)
WUL Limit			5.0 - 10.0	750	3800	-	-	-	300	500	40	5	500	3200	20	10	10	-	5	10	20	15	10	20	-	-	100	1000	0.15	10
General Authorisation Limits			5.5-9.5	150	-	-	-	-	-	-	-	1	-	-	0.3	0.1	-	-	0.05	6	15	-	10	-	-	-	-	2.5	-	-
Process Water																														
WLV-PIT	21/11/2019	Rehabilitated																												
	05/12/2019	Rehabilitated																												
	16/01/2020	Rehabilitated																												
	06/02/2020	Rehabilitated																												
	09/03/2020	Rehabilitated																												
	08/05/2020	Rehabilitated																												
	19/05/2020	Rehabilitated																												
	02/06/2020	Rehabilitated																												
	07/07/2020	Rehabilitated																												
	13/08/2020	Rehabilitated																												
	09/09/2020	Rehabilitated																												
	02/10/2020	Rehabilitated																												
WP04	21/11/2019	No Access																												
	05/12/2019		7.64	447.0	4633	3339	52	623.0	433.0	156.0	28.10	0.13	46.50	3314	0.24	0.26	<0.01	0.17	<0.02	<0.45	<0.35	<0.45	<0.03	0.03	108.00	6.78	26.40	0.80	<0.001	0
	16/01/2020		7.56	503.0	4908	3550	60	630.0	480.0	165.0	30.80	0.14	52.90	3512	0.24	0.26	<0.01	0.15	<0.02	<0.45	<0.35	<0.45	<0.03	0.03	70.20	6.28	29.10	1.40	<0.001	0
	06/02/2020	No Access																												
	10/03/2020		8.00	231.0	2162	1608	231	405.0	145.0	37.2	10.80	<0.09	15.90	1363	0.03	0.13	<0.01	<0.01	<0.02	0.52	10.10	10.91	<0.03	0.13	14.20	6.42	3.66	0.70	<0.001	12
	08/05/2020		7.80	254.0	2395	1737	50	425.0	164.0	43.2	11.40	<0.09	14.30	1654	0.04	0.20	<0.01	<0.01	0.03	0.97	10.80	13	<0.03	0.10	9.03	6.68	6.58	1.60	0.01	0
	19/05/2020		8.15	255.0	2344	1698	54	411.0	163.0	46.0	13.50	<0.09	13.80	1609	0.02	0.15	<0.01	0.04	0.01	1.32	11.40	13.4	<0.03	0.01	8.98	6.71	6.64	0.60	<0.001	8
	02/06/2020		7.73	255.0	2393	1708	55	412.0	165.0	48.2	14.00	<0.09	14.30	1650	0.10	0.20	<0.01	0.06	<0.01	1.32	12.20	14.1	<0.03	0.36	5.35	7.65	5.72	0.80	0.01	0
	07/07/2020		7.93	257.0	2412	1701	61	406.0	167.0	43.0	12.50	<0.09	13.50	1686	0.69	0.27	<0.01	0.07	0.07	0.86	10.20	11.51	<0.03	0.19	5.08	7.49	3.20	6.67	0.02	0
	13/08/2020		7.69	259.0	2533	1815	67	417.0	188.0	51.2	14.70	<0.09	13.80	1746	<0.01	0.09	<0.01	<0.01	<0.01	1.88	13.60	15.9	<0.03	0.10	3.89	7.55	4.32	5.00	0.00	0
	09/09/2020		7.42	263.0	2648	1831	69	420.0	190.0	44.7	14.00	0.42	15.10	1836	0.02	0.26	<0.01	0.17	0.03	17.00	14.30	31.8	<0.03	0.15	9.35	7.68	5.54	0.67	<0.001	6
	02/10/2020		7.99	273.0	2602	1891	64	439.0	193.0	53.5	16.20	<0.09	16.70	1793	<0.01	0.22	<0.01	0.16	<0.02	2.55	10.80	14.14	<0.03	0.15	5.18	7.26	4.42	0.27	<0.001	2

Exxaro Leeuwpan																													
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Boron (B)	Hexavalent Chromium (Cr^{6})	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Total Inorganic Nitrogen (mg/l)	Ortho Phosphate as P (mg/l)	Total Phosphate	Turbidity	Dissolved Oxygen (DO)	Dissolved Organic Carbon (DOC)	Oil & Grease	Chlorofyl-a	Escherichia coli (E.coli)
WUL Limit			5.0 - 10.0	750	3800	-	-	-	300	500	40	5	500	3200	20	10	10	-	5	10	20	15	10	20	-	-	100	1000	0.15	10
General Authorisation Limits			5.5-9.5	150	-	-	-	-	-	-	-	1	-	-	0.3	0.1	-	-	0.05	6	15	-	10	-	-	-	-	2.5	-	-
Process Water																													
Comparrison Samples																													
OWM_PIT A	18/07/2019		8.93	59.4	381	210	116	42.4	25.4	48.7	1.68	1.38	1.39	190	<0.01	<0.01	0.05	0.04	<0.02	<0.45	<0.35	<0.45	<0.03	0.02	2.20	7.23	7.20	2.00	0.01	0
OWP - Pit B Surface	15/10/2019		8.26	128.0	779	501	97	92.7	65.5	53.3	2.14	0.52	3.90	503	0.03	<0.01	<0.01	0.04	<0.02	<0.45	<0.35	<0.45	<0.03	0.42	34.30	5.44	12.00	1.20	0.00	4
LSW09 A	15/10/2019		7.64	320.0	3056	2161	103	519.0	210.0	46.2	13.00	<0.09	18.20	2144	<0.01	<0.01	<0.01	0.11	<0.02	1.16	8.54	10.9	<0.03	0.03	73.60	5.66	6.54	1.60	0.01	0
KR01B	20/08/2019		7.92	325	2897	2134	184	490	221	45.1	15.3	<0.09	15.5	1999	0.02	0.02	<0.01	0.08	<0.02	<0.45	<0.35	<0.45	<0.03	0.03	6.4	6.48	6.27	3.00	0.03	12
	15/10/2019		7.91	381	3708	2753	164	649	275	56.7	15.6	<0.09	19.2	2594	0.03	<0.01	<0.01	0.10	<0.02	<0.45	<0.35	<0.45	<0.03	<0.03	18.7	5.21	5.30	2.40	<0.001	12
WP04 A	07/07/2020		7.93	257	2343	1682	63	400	166	42.5	12.3	<0.09	12.9	1624	0.69	0.27	<0.01	0.07	0.07	1.14	10.20	11.80	<0.03	0.34	5.0	7.62	2.85	2.22	0.01	0

Table 6: Effluent Water Sample Results

Exxaro - Leeuwpan										
Sample Number	Date	Comment	Suspended Solids (SS) mg/l	Ammonia mg/l	Nitrate (N) mg/l	Ortho-phosphate mg/l	Total Phosphate mg/l	Chemical Oxygen Demand (total)	Escherichia coli (E.coli)	Faecal Coliforms
Exxaro - Leeuwpan Wastewater WUL Limit			-	10	20	10	20	-	10	-
General Authorisation Limits			25	6	15	10	-	75	-	1000
Treated Sewage										
LWP_SP_P	21/11/2019		62.80	119.00	<0.35	4.70	5.82	251.00	1500	1500
	05/12/2019		37.20	133.00	<0.35	3.95	7.31	197.00	1500	1500
	16/01/2020		56.80	72.40	<0.35	4.34	5.34	164.00	1500	1500
	06/02/2020		96.80	94.10	6.05	3.13	4.60	258.00	0	0
	10/03/2020		6.40	93.90	3.18	3.73	5.02	123.00	0	0
	08/05/2020		30.80	55.00	1.71	3.39	4.55	108.00	0	40
	18/05/2020		132.00	50.10	1.64	4.48	5.37	238.00	130	1500
	02/06/2020		275.00	36.30	3.06	3.55	4.75	494.00	0	0
	07/07/2020		76.00	78.00	7.34	2.59	5.48	202.00	0	0
	13/08/2020		164.00	24.90	7.70	2.70	4.80	278.00	0	10
	07/09/2020	Not Active								
	02/10/2020	Not Active								

Exxaro - Leeuwpan										
Sample Number	Date	Comment	Suspended Solids (SS) mg/l	Ammonia mg/l	Nitrate (N) mg/l	Ortho-phosphate mg/l	Total Phosphate mg/l	Chemical Oxygen Demand (total)	Escherichia coli (E.coli)	Faecal Coliforms
Exxaro - Leeuwpan Wastewater WUL Limit			-	10	20	10	20	-	10	-
General Authorisation Limits			25	6	15	10	-	75	-	1000
Treated Sewage										
LWP_SP_W	21/11/2019	Maintenance								
	05/12/2019	Maintenance								
	16/01/2020	Maintenance								
	09/03/2020	Maintenance								
	08/05/2020	Maintenance								
	18/05/2020	Maintenance								
	02/06/2020	Maintenance								
	07/07/2020	Maintenance								
	13/08/2020	Maintenance								
	08/09/2020	No Access								
	02/10/2020	No Access								

Table 7: Potable Water Sample Results

Exxaro - Leeuwpan																								
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids (mg/l)	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO 4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Ortho Phosphate as P (mg/l)	Turbidity (NTU)	Dissolved Oxygen (DO mg/l)	Sodium Absorption Ratio (indicative)	Escherichia coli (E.coli count per 100ml)	Heterotrophic plate count
SANS 241:2015 Strd. Lim. (Operational)			5.0 - 9.7	≤ 170	≤ 1200	-	-	-		≤ 200	-	≤ 1.5	≤ 300	≤ 500	≤ 2	≤ 0.4	≤ 0.3	≤ 1.5	≤ 12	-	≤ 5	-	-	0	≤1000
Potable Water																								
LDWST	21/11/2019	No Access																						
	05/12/2019		7.85	59.1	327	216	147	44.7	25.3	31.9	4.33	0.19	47.9	76.7	0.03	<0.01	<0.01	<0.45	1.76	<0.03	2.37	7.12	0.94	128	3000
	16/01/2020		7.92	56.8	334	233	153	51.8	25.1	29.2	4.60	0.16	42.9	80.5	0.04	<0.01	<0.01	<0.45	1.7	<0.03	1.19	6.90	0.83	0	2900
	06/02/2020		7.67	58.0	308	232	146	49.5	26.4	21.7	1.94	0.15	41.2	72.4	<0.01	<0.01	<0.01	<0.45	1.67	<0.03	1.62	7.38	0.62	0	870
	10/03/2020		7.97	59.2	327	227	144	49.5	25.1	30.9	4.49	0.13	43.9	78.7	<0.01	<0.01	<0.01	<0.45	1.78	0.03	1.76	6.15	0.89	2	3000
	08/05/2020		7.73	59.0	336	226	149	51.1	24.0	31.3	4.27	<0.09	45	81.7	0.10	0.03	0.09	<0.45	2.02	<0.03	10.50	6.20	0.90	20	3000
	18/05/2020		7.83	60.2	342	234	149	48.9	27.1	33.2	4.89	<0.09	44.4	84.0	0.02	0.03	<0.01	<0.45	2.13	<0.03	3.19	6.29	0.94	0	740
	02/06/2020	No Water																						
	07/07/2020		7.74	60.2	322	208	154	45.7	22.9	31.4	4.63	<0.09	47.2	69.0	0.01	0.04	<0.01	<0.45	1.8	<0.03	2.35	6.62	0.94	0	370
	13/08/2020		7.59	57.6	321	201	155	40.7	24.2	36.1	5.10	<0.09	40.9	75.4	<0.01	0.03	<0.01	<0.45	1.3	<0.03	1.65	7.69	1.10	0	3000
	09/09/2020		8.00	58.4	331	206	148	41.4	24.8	37.2	4.69	0.24	51.9	74.6	<0.01	0.02	<0.01	<0.45	1.57	<0.03	2.09	7.64	1.12	0	3000
	02/10/2020		7.81	63.0	355	240	154	46.1	30.4	35.6	4.36	0.16	55.5	81.7	0.01	0.02	<0.01	<0.45	1.74	<0.03	1.33	7.61	1.00	0	3000

Exxaro - Leeuwpan																								
Sample Number	Date	Comment	Arsenic as As (mg/l)	Boron as B (mg/l)	Barium as Ba (mg/l)	Cadmium as Cd (mg/l)	Cobalt as Co (mg/l)	Chromium as Cr (mg/l)	Copper as Cu (mg/l)	Molybdenum as Mo (mg/l)	Nickel as Ni (mg/l)	Lead as Pb (mg/l)	Selenium as Se (mg/l)	Silicon as Si (mg/l)	Strontium as Sr (mg/l)	Titanium as Ti (mg/l)	Vanadium as V (mg/l)	Zinc as Zn (mg/l)	Mercury as Hg (mg/l)	Lanthanum as La (mg/l)	Lithium as Li (mg/l)	Antimony as Sb (mg/l)	Tin as Sn (mg/l)	Thorium as Th (mg/l)	Thallium as Tl (mg/l)
SANS 241:2015 Strd. Lim. (Operational)			≤ 0.010	≤ 2.400	≤ 0.700	≤ 0.003	-	≤ 0.050	≤ 2	-	≤ 0.070	≤ 0.010	≤ 0.040	-	-	-	-	≤ 5	≤ 0.006	-	-	≤ 0.020	-	-	-
Potable Water			Potable Water																					
LDWST	21/11/2019	No Access																						
	05/12/2019		<0.005	0.07	0.04	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	11.10	0.51	<0.01	<0.01	<0.01	<0.003	<0.01	0.08	<0.01	0.04	<0.01	0.09
	16/01/2020		<0.05	0.05	0.03	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	12.60	0.38	<0.01	0.40	0.12	<0.03	<0.01	0.06	<0.01	0.04	0.06	0.08
	06/02/2020		<0.005	0.01	0.08	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	6.70	0.11	<0.01	<0.01	0.04	<0.003	<0.01	0.02	<0.01	0.26	0.01	0.01
	10/03/2020		<0.005	<0.01	0.04	0.01	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	10.80	0.32	<0.01	<0.01	<0.01	<0.003	<0.01	0.05	0.18	0.05	<0.01	0.08
	08/05/2020		<0.005	<0.01	0.04	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	12.10	0.39	<0.01	<0.01	<0.01	<0.003	<0.01	0.06	<0.01	<0.01	<0.01	0.06
	18/05/2020		<0.005	0.04	0.04	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	11.10	0.36	<0.01	<0.01	<0.01	<0.003	<0.01	0.06	0.01	<0.01	<0.01	0.01
	02/06/2020	No Water																						
	07/07/2020		<0.005	0.05	0.07	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	9.06	0.44	<0.01	<0.01	0.01	<0.003	<0.01	0.08	<0.01	<0.01	<0.01	<0.01
	13/08/2020		<0.005	<0.01	0.06	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	6.40	0.44	<0.01	<0.01	0.01	<0.003	<0.01	0.07	<0.01	<0.01	<0.01	<0.01
	09/09/2020		<0.005	<0.01	0.06	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	9.77	0.46	<0.01	<0.01	0.02	<0.003	<0.01	0.09	<0.01	<0.01	<0.01	<0.01
	02/10/2020		<0.005	0.10	0.08	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	10.40	0.60	<0.01	<0.01	<0.01	<0.003	<0.01	0.12	<0.01	<0.01	<0.01	<0.01

Exxaro - Leeuwpan																								
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids (mg/l)	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO 4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Ortho Phosphate as P (mg/l)	Turbidity (NTU)	Dissolved Oxygen (DO mg/l)	Sodium Absorption Ratio (indicative)	Escherichia coli (E.coli count per 100ml)	Heterotrophic plate count
SANS 241:2015 Strd. Lim. (Operational)			5.0 - 9.7	≤ 170	≤ 1200	-	-	-		≤ 200	-	≤ 1.5	≤ 300	≤ 500	≤ 2	≤ 0.4	≤ 0.3	≤ 1.5	≤ 12	-	≤ 5	-	-	0	≤1000
Potable Water																								
LLBDW	20/11/2019		8.14	50.4	261	191	176	39.4	22.6	23.3	2.87	0.1	23.2	43.0	0.39	0.03	<0.01	<0.45	<0.35	0.11	5.90	5.33	0.73	0	3000
	05/12/2019		8.08	50.7	270	208	178	38.2	27.3	21.3	3.23	0.17	25.3	47.5	<0.01	0.04	<0.01	<0.45	<0.35	0.04	7.45	7.06	0.64	0	3000
	16/01/2020		7.85	52.1	279	209	180	42.8	24.8	24.8	3.59	0.16	29.3	44.5	0.23	0.02	0.01	<0.45	<0.35	0.07	6.44	6.50	0.74	0	2800
	06/02/2020		7.89	49.3	288	207	168	40.9	25.4	29.4	2.55	0.16	24.4	63.7	0.15	<0.01	<0.01	<0.45	<0.35	<0.03	27.70	7.13	0.89	0	3000
	09/03/2020		7.81	49.3	255	194	167	34.2	26.4	23.4	3.54	0.13	24.4	42.4	0.14	0.01	<0.01	<0.45	<0.35	0.04	3.63	6.28	0.73	0	3000
	08/05/2020		7.97	48.1	262	198	173	36.8	25.7	22.7	3.08	<0.09	25.1	44.5	<0.01	0.02	<0.01	<0.45	<0.35	<0.03	8.20	6.10	0.70	0	3000
	18/05/2020		7.96	54.2	291	218	173	40.0	28.6	28.0	4.24	<0.09	34.6	51.2	0.30	0.05	<0.01	<0.45	<0.35	<0.03	4.06	6.22	0.82	0	3000
	02/06/2020		7.82	50.4	263	202	185	37.9	26.1	23.1	3.31	<0.09	20	41.1	0.19	0.03	<0.01	<0.45	<0.35	<0.03	3.32	6.10	0.70	0	3000
	07/07/2020		7.89	50.6	264	198	186	38.4	24.7	21.2	3.31	<0.09	25	39.7	<0.01	0.02	<0.01	<0.45	<0.35	<0.03	19.30	7.17	0.65	16	380
	13/08/2020		7.74	271.0	2807	1993	119	495.0	184.0	47.4	14.60	0.21	15.8	1828.0	<0.01	0.02	<0.01	<0.45	33.8	<0.03	12.40	7.21	0.46	0	3000
	09/09/2020		7.75	246.0	2242	1567	96	377.0	152.0	40.9	11.20	<0.09	20.1	1562.0	0.16	0.28	<0.01	<0.45	4.47	<0.03	8.83	7.77	0.45	34	3000
	02/10/2020		7.85	251.0	2293	1681	113	396.0	168.0	50.6	12.80	<0.09	24.2	1555.0	<0.01	0.03	<0.01	<0.45	4	<0.03	5.95	7.54	0.54	40	3000
LWDL	21/11/2019		8.02	59.4	319	229	148	53.5	23.1	27.8	3.93	0.09	42.7	72.7	0.02	<0.01	<0.01	<0.45	1.47	<0.03	1.60	5.76	0.73	0	3000
	05/12/2019		7.97	59.4	328	215	147	44.5	25.2	33.2	4.48	0.24	49.7	74.9	0.05	<0.01	<0.01	<0.45	1.68	<0.03	1.66	7.12	0.98	0	2400
	16/01/2020		7.92	56.9	334	232	152	51.6	25.0	29.1	4.60	0.16	43.6	80.3	0.04	<0.01	<0.01	<0.45	1.74	<0.03	1.02	6.88	0.83	0	2700
	06/02/2020		7.93	58.1	316	225	152	49.0	24.9	29.4	2.53	0.18	40.8	70.2	<0.01	0.03	<0.01	<0.45	1.79	<0.03	4.43	7.54	0.85	0	2040
	09/03/2020		7.92	58.6	325	219	155	46.8	24.8	30.8	4.60	0.15	43.9	72.6	0.03	<0.01	<0.01	<0.45	1.79	<0.03	0.92	6.34	0.90	0	3000
	08/05/2020		8.01	58.6	333	225	152	50.7	23.9	30.9	4.14	<0.09	44.1	78.3	0.02	<0.01	<0.01	<0.45	2.08	<0.03	1.34	6.41	0.89	0	1920
	18/05/2020		8.01	63.0	347	234	154	49.2	27.1	37.4	4.89	<0.09	44.8	82.5	<0.01	<0.01	<0.01	<0.45	1.93	<0.03	0.48	6.56	1.06	0	168
	02/06/2020		7.96	59.4	329	123	150	44.6	24.8	33.4	4.40	<0.09	44.1	79.7	0.03	<0.01	<0.01	<0.45	1.73	<0.03	0.89	6.39	0.99	0	3000
	07/07/2020		7.93	57.2	308	200	151	42.7	22.6	30.4	4.51	<0.09	43.2	65.6	0.01	<0.01	<0.01	<0.45	1.79	<0.03	0.56	7.40	0.93	14	330
	13/08/2020		7.64	264.0	2575	1881	86	443.0	188.0	52.2	15.70	<0.09	14	1771.0	<0.01	<0.01	<0.01	<0.45	8.9	<0.03	15.00	7.44	0.52	0	2200
	09/09/2020		7.86	266.0	2489	1720	82	415.0	166.0	44.9	13.50	<0.09	15.7	1745.0	0.02	0.15	<0.01	<0.45	8.92	<0.03	3.20	7.21	0.47	0	1640
	02/10/2020		7.71	284.0	2814	1994	88	457.0	207.0	52.1	13.30	<0.09	18.7	1970.0	<0.01	0.21	<0.01	<0.45	9.31	<0.03	0.97	7.83	0.51	0	3000

Exxaro - Leeuwpan																								
Sample Number	Date	Comment	Arsenic as As (mg/l)	Boron as B (mg/l)	Barium as Ba (mg/l)	Cadmium as Cd (mg/l)	Cobalt as Co (mg/l)	Chromium as Cr (mg/l)	Copper as Cu (mg/l)	Molybdenum as Mo (mg/l)	Nickel as Ni (mg/l)	Lead as Pb (mg/l)	Selenium as Se (mg/l)	Silicon as Si (mg/l)	Strontium as Sr (mg/l)	Titanium as Ti (mg/l)	Vanadium as V (mg/l)	Zinc as Zn (mg/l)	Mercury as Hg (mg/l)	Lanthanum as La (mg/l)	Lithium as Li (mg/l)	Antimony as Sb (mg/l)	Tin as Sn (mg/l)	Thorium as Th (mg/l)	Thallium as Tl (mg/l)
SANS 241:2015 Strd. Lim. (Operational)			≤ 0.010	≤ 2.400	≤ 0.700	≤ 0.003	-	≤ 0.050	≤ 2	-	≤ 0.070	≤ 0.010	≤ 0.040	-	-	-	-	≤ 5	≤ 0.006	-	-	≤ 0.020	-	-	-
Potable Water			Potable Water																					
LLBDW	20/11/2019		<0.005	<0.01	0.08	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	15.60	0.16	<0.01	<0.01	0.03	<0.003	<0.01	0.02	<0.01	0.06	0.03	<0.01
	05/12/2019		<0.005	0.05	0.08	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	7.63	0.18	<0.01	<0.01	0.01	<0.003	<0.01	0.02	<0.01	0.04	<0.01	0.09
	16/01/2020		<0.05	0.05	0.08	<0.02	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	0.02	8.88	0.13	<0.01	0.21	0.04	<0.03	<0.01	0.02	0.01	0.14	0.05	0.07
	06/02/2020		<0.005	0.01	0.03	<0.002	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	11.40	0.33	<0.01	<0.01	0.13	<0.003	<0.01	0.06	<0.01	0.22	0.02	0.01
	09/03/2020		<0.005	<0.01	0.08	0.01	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	6.79	0.10	<0.01	<0.01	0.03	<0.003	<0.01	0.02	0.18	0.06	<0.01	0.09
	08/05/2020		<0.005	<0.01	0.07	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	7.14	0.12	<0.01	<0.01	0.03	<0.003	<0.01	0.02	0.01	<0.01	<0.01	0.04
	18/05/2020		<0.005	0.04	0.09	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	7.24	0.12	<0.01	<0.01	<0.01	<0.003	<0.01	0.02	0.01	<0.01	<0.01	<0.01
	02/06/2020		<0.005	0.02	0.09	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	7.08	0.13	<0.01	<0.01	<0.01	<0.003	<0.01	0.02	<0.01	<0.01	<0.01	<0.01
	07/07/2020		<0.005	0.04	0.08	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	6.30	0.15	<0.01	<0.01	0.02	<0.003	<0.01	0.02	<0.01	<0.01	<0.01	<0.01
	13/08/2020		<0.005	<0.01	0.06	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	1.80	2.49	<0.01	<0.01	0.78	<0.003	<0.01	0.09	<0.01	<0.01	<0.01	<0.01
	09/09/2020		<0.005	<0.01	0.08	<0.002	<0.01	<0.01	<0.01	0.06	<0.01	<0.01	<0.01	6.38	2.24	<0.01	<0.01	0.28	<0.003	<0.01	0.10	<0.01	<0.01	<0.01	<0.01
	02/10/2020		<0.005	0.11	0.05	<0.002	<0.01	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	5.70	2.81	<0.01	<0.01	0.24	<0.003	<0.01	0.12	<0.01	<0.01	<0.01	<0.01
LWDL	21/11/2019		<0.005	<0.01	0.03	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	21.50	0.40	<0.01	<0.01	0.16	<0.003	<0.01	0.04	<0.01	0.05	0.04	<0.01
	05/12/2019		<0.005	0.07	0.04	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	11.00	0.52	<0.01	<0.01	0.21	<0.003	<0.01	0.08	<0.01	0.04	<0.01	0.06
	16/01/2020		<0.05	0.05	0.03	<0.02	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.02	12.40	0.38	<0.01	0.40	0.12	<0.03	<0.01	0.06	<0.01	0.04	0.06	0.08
	06/02/2020		<0.005	0.01	0.03	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	11.30	0.33	<0.01	<0.01	<0.01	<0.003	<0.01	0.06	<0.01	0.25	0.01	0.01
	09/03/2020		<0.005	<0.01	0.04	0.01	<0.01	0.03	0.03	<0.01	<0.01	<0.01	<0.01	10.70	0.31	<0.01	<0.01	0.06	<0.003	<0.01	0.05	0.18	0.05	<0.01	0.02
	08/05/2020		<0.005	<0.01	0.04	<0.002	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	11.70	0.39	<0.01	<0.01	0.05	<0.003	<0.01	0.06	<0.01	<0.01	<0.01	0.08
	18/05/2020		<0.005	0.05	0.04	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	11.10	0.37	<0.01	<0.01	0.04	<0.003	<0.01	0.06	0.01	<0.01	<0.01	<0.01
	02/06/2020		<0.005	0.04	0.03	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	9.53	0.35	<0.01	<0.01	0.03	<0.003	<0.01	0.06	<0.01	<0.01	<0.01	<0.01
	07/07/2020		<0.005	0.05	0.07	<0.002	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	9.10	0.43	<0.01	<0.01	0.04	<0.003	<0.01	0.08	<0.01	<0.01	<0.01	<0.01
	13/08/2020		<0.005	<0.01	<0.01	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.32	<0.01	<0.01	<0.01	0.01	<0.003	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	09/09/2020		<0.005	<0.01	0.08	<0.002	<0.01	<0.01	<0.01	0.06	<0.01	<0.01	<0.01	5.45	3.25	<0.01	<0.01	0.14	<0.003	<0.01	0.10	<0.01	<0.01	<0.01	<0.01
	02/10/2020		<0.005	0.14	0.06	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	6.95	4.33	<0.01	<0.01	0.02	<0.003	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Exxaro - Leeuwpan																									
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids (mg/l)	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO 4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Ortho Phosphate as P (mg/l)	Turbidity (NTU)	Dissolved Oxygen (DO mg/l)	Sodium Absorption Ratio (indicative)	Escherichia coli (E.coli count per 100ml)	Heterotrophic plate count
SANS 241:2015 Strd. Lim. (Operational)			5.0 - 9.7	≤ 170	≤ 1200	-	-	-		≤ 200	-	≤ 1.5	≤ 300	≤ 500	≤ 2	≤ 0.4	≤ 0.3	≤ 1.5	≤ 12	-	≤ 5	-	-	0	≤1000
Potable Water																									
PIET-SCHUTTE	21/11/2019	No Water																							
	05/12/2019	No Water																							
	16/01/2020	No Water																							
	06/02/2020	No Water																							
	09/03/2020	No Water																							
	08/05/2020	No Water																							
	18/05/2020	No Water																							
	02/06/2020	No Water																							
	07/07/2020	No Water																							
	13/08/2020	No Water																							
	07/09/2020	No Water																							
	02/10/2020	No Water																							
Comparitive Sample																									
LLBDWA	05/12/2019		8.06	51.0	275	220	180	40.9	28.7	23.0	3.02	0.17	26.2	44.3	0.31	0.03	<0.01	<0.45	<0.35	<0.03	12.00	7.10	0.67	0	3000
	16/01/2020		8.05	51.8	274	211	180	42.7	25.3	23.2	3.05	0.17	26.2	44.6	0.37	0.03	<0.01	<0.45	<0.35	<0.03	7.24	6.42	0.69	0	2500
	06/02/2020		7.88	49.1	257	207	173	35.7	28.6	21.4	2.94	0.16	24.7	39.2	0.02	0.02	<0.01	<0.45	<0.35	<0.03	7.54	7.61	0.64	0	3000
	09/03/2020		7.76	49.3	262	194	178	34.2	26.3	23.4	3.49	0.14	25.3	42.3	0.14	0.01	<0.01	<0.45	<0.35	<0.03	5.25	6.01	0.73	0	3000

Exxaro - Leeuwpan																								
Sample Number	Date	Comment	Arsenic as As (mg/l)	Boron as B (mg/l)	Barium as Ba (mg/l)	Cadmium as Cd (mg/l)	Cobalt as Co (mg/l)	Chromium as Cr (mg/l)	Copper as Cu (mg/l)	Molybdenum as Mo (mg/l)	Nickel as Ni (mg/l)	Lead as Pb (mg/l)	Selenium as Se (mg/l)	Silicon as Si (mg/l)	Strontium as Sr (mg/l)	Titanium as Ti (mg/l)	Vanadium as V (mg/l)	Zinc as Zn (mg/l)	Mercury as Hg (mg/l)	Lanthanum as La (mg/l)	Lithium as Li (mg/l)	Antimony as Sb (mg/l)	Tin as Sn (mg/l)	Thorium as Th (mg/l)	Thallium as Tl (mg/l)
SANS 241:2015 Strd. Lim. (Operational)			≤ 0.010	≤ 2.400	≤ 0.700	≤ 0.003	-	≤ 0.050	≤ 2	-	≤ 0.070	≤ 0.010	≤ 0.040	-	-	-	-	≤ 5	≤ 0.006	-	-	≤ 0.020	-	-	-
Potable Water			Potable Water																					
PIET-SCHUTTE	21/11/2019	No Water																						
	05/12/2019	No Water																						
	16/01/2020	No Water																						
	06/02/2020	No Water																						
	09/03/2020	No Water																						
	08/05/2020	No Water																						
	18/05/2020	No Water																						
	02/06/2020	No Water																						
	07/07/2020	No Water																						
	13/08/2020	No Water																						
	07/09/2020	No Water																						
	02/10/2020	No Water																						
Comparitive Sample																								
LLBDWA	05/12/2019		<0.005	0.05	0.07	<0.002	<0.01	<0.01	0.01	0.01	<0.01	<0.01	<0.01	7.05	0.15	<0.01	<0.01	0.03	<0.003	<0.01	0.02	<0.01	0.02	<0.01	0.04
	16/01/2020		<0.05	0.05	0.08	<0.02	<0.01	<0.01	0.01	0.01	<0.01	<0.01	<0.01	10.90	0.16	<0.01	<0.01	0.04	<0.03	<0.01	0.02	<0.01	0.04	0.04	0.04
	06/02/2020		<0.005	0.04	0.11	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	0.15	<0.01	<0.01	<0.01	<0.003	<0.01	0.08	<0.01	0.02	0.03	<0.01
	09/03/2020		<0.005	<0.01	0.09	0.01	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	6.82	0.10	<0.01	<0.01	0.02	<0.003	<0.01	0.02	0.18	0.06	<0.01	0.06

7. DISCUSSION

7.1 RECEIVING ENVIRONMENT WATER QUALITY

Surface water monitoring was performed at ten (10) monitoring localities during the monitoring period. The following samples were recorded as dry during the site assessment:

- LSW06, LSW07, LSW08, LSW12, WP01 and RD1.

The majority of the sampled receiving environment monitoring localities water quality analysis indicated exceedances in terms of the DWAF Domestic Guideline Limits for Turbidity, Calcium and Dissolved Organic Carbon (DOC mg/l). Additional exceedances included the Calcium (Ca), Magnesium (Mg), Sulphate (SO_4), Manganese (Mn) and *E.coli*.

From the October 2020 results it is evident that the majority of the receiving environment monitoring localities presented overall fair condition. Turbidity within the surface water samples are expected, as turbidity refers to the measurement of the cloudiness or muddiness of water, which is influenced by both natural (flow velocity, rainfall, run-off etc.) and anthropogenic activities (disturbance / mining activities). Overall, the Total Inorganic Nitrogen (TIN), Nitrate (NO_3-N) and the Ammonia (NH_3-N) levels remained low, with the majority (excluding LSW13) of the concentrations recording below the detection limit.

Duplicate samples were obtained from monitoring localities LSW03, LSW05 and WP02 in order to determine the accuracy and precision of inter-laboratory results. Comparison of the calculated TDS and computation of relative percent difference for the duplicate pairs were calculated between a range of 0.0 to 3.65 % for the October 2020 monitoring run, recording within the acceptable range (30%).

7.2 PROCESS WATER QUALITY

Process water monitoring was performed at sixteen (16) monitoring localities during the monitoring period. The following samples could not be obtained during the monitoring run:

- KR03, KR04, OG PIT, OH PIT, OJ PIT, OM PIT, WLV PIT and OWM-PIT. Please refer to the sampling register as presented in Appendix A for details.

All of the monitored process localities revealed compliance to the stipulated WUL limits. The October 2020 exceedances can be summarised as follows:

- KR01A , LSW09 and WP04
    - General Authorisation Limit: Electrical Conductivity (EC) and Manganese (Mn)
- ODN PIT
    - General Authorisation Limit: Electrical Conductivity (EC) and Manganese (Mn)
    - WUL Limit: *E.coli*

Discharge of the process water into the receiving environment is prohibited according to the General Authorisation (Section 21f and h, 2013) as it could have limiting effects on the receiving water environment. Note that regular maintenance on process water facilities linings and transfer pipes are vital for water resource protection.

7.3 EFFLUENT WATER QUALITY

Final effluent samples are collected at two (2) monitoring localities inclusive of the Septic tanks at plant and the Final effluent from the sewage plant.

The final effluent from LWP-SP-P historically recorded non-compliant to the set Ammonia Wastewater WUL limits, while exceedances related to the General Authorisation limits included Suspended Solids, Ammonia and Chemical Oxygen Demand.

During the monitoring period it was noted that the LWP-SP-P was not active and no acces was obtained to the LWP-SP-W monitoring point.

7.4 POTABLE WATER QUALITY

Four (4) potable water localities form part of the monitoring programme at Exxaro Leeuwpan Mine. **It should be noted that the water is not used as a potable source, however monitored as such in case of accidental consumption as a precautionary measurement**. During the monitoring period a sample could not be obtained from PIET-SCHUTTE as water was not pumping.

The potable water quality at Leeuwpan can generally (historical results) be described as neutral, non-saline and hard while elevated salinity and Total Hardness was present from Load-Out Bay Offices (LLBDW) and Drinking Water at Laboratory (LWDL) during October 2020. The Load-Out Bay Offices (LLBDW) revealed exceedances of Electrical Conductivity (EC), Total Dissolved Solids (TDS), Sulphate (SO_4), Turbidity, Heterotrophic Plate Counts and *E.coli* which renders the water as

not suitable for potable purposes. The Drinking Water Supply Tank (LDWST) presented an exceedance of Heterotrophic Plate Counts, while the remainder of the parameters presented ideal water quality. The Drinking Water at Laboratory (LWDL) presented an exceedance of Electrical Conductivity (EC), Total Dissolved Solids (TDS), Sulphate (SO_4) and Heterotrophic Plate Counts;

Based on the historical analysed parameters and data, the potable water poses a risk for infection due to the elevated Heterotrophic Plate Counts and thus it is strongly advised that the water be treated and filters regularly disinfected and cleaned as the high counts may be attributed to biofilms.

7.5 EXCEEDING VARIABLE DISCUSSION

Salinity (EC and TDS)

A high salinity level in water is associated with a salty taste and does not necessarily slake thirst. Health effects occur only at levels above 370 mS/m and may include disturbance of salt and water balance within infants. Individuals with renal or heart diseases, as well as high blood pressure are particularly vulnerable to adverse effects. Under irrigation, saline soils are formed primarily when high salinity water is used for irrigation; this in return results in a higher leaching fraction, influencing the crop yield. Wetting of the foliage of salt-sensitive crops should be avoided using water with EC concentrations between 40 and 90 mS/m. Increasing problems with encrustation of irrigation pipes and clogging of drip irrigation may be experienced.

Chemical Oxygen Demand

The Chemical Oxygen Demand, or COD for short, is a measure of the oxygen equivalent of the organic matter content in a sample that is susceptible to oxidation by a strong oxidising agent and is therefore an estimate of the organic matter levels present in water. Human activities such as agricultural the production of industrial and domestic wastes are significant sources of organic matter. The organic matter can be present either in dissolved form or as particulate organic matter. The former may be associated with undesirable tastes and odours, while the particulate organic matter contributes to the suspended solids load of a water body (South African Water Quality Guidelines 1996). The COD gives a rough indication of organic matter content in the water that will be available for decomposition (an oxygen depleting process) and ultimately nutrients for plant and algae growth. In terms of wastewater used for irrigation, the organic matter is a substrate for bacterial growth which, at high levels, may therefore lead to bacterial after-growth and fouling or clogging of the irrigation system.

Manganese

Manganese is an essential element in the diet of humans and animals, therefore adverse health effects are expected due to both a shortage and overdose thereof. Manganese may affect the taste of drinking water at concentrations exceeding 0.1 mg/l, while a black precipitate will form in water pipes at concentrations exceeding 0.2 mg/l. The solubility of manganese in groundwater varies from good to poor depending on the nature of the chemical compound.

Adverse aesthetic effects limit the acceptability of manganese-containing water for domestic use at concentrations exceeding 0.15 mg/l. Manganese is nutritionally essential in small amount for cartilage integrity, but supports growth of

certain nuisance organisms in water distribution systems, giving rise to taste, odour and turbidity problems. Thus, an unpleasant taste and staining of plumbing fixtures and laundry occurs. Health problems associated with manganese concentration in water are rare, neurotoxic effects may occur at high concentrations, but overall manganese is considered to be one of the least potentially harmful of the elements.

Nitrate (NO_3)

High nitrate levels are regularly associated with mining operations as nitrate is a major component of most explosives used in the mining sector and remnants of the nitrate finds its way into process water sources and hence natural resources such as groundwater. Other major sources of nitrate include agricultural practices such as feedlotting and kraaling (nitrate in animal manure) and crop production (nitrate in fertilizer) as well as human sanitation (pit latrines, septic tank systems, sewage treatment plants; in association with phosphate and pathogens) and also certain natural sources such as nitrogen fixation through leguminous plants. When consumed in high concentrations, nitrate causes methaemoglobinaemia due to reduction of nitrate (NO_3) to nitrite (NO_2) in the gastrointestinal tract. Nitrite readily binds to haemoglobin, the red oxygen-carrying blood pigment, rendering it inactive which leads to oxygen deficiency in the body tissues.

Nitrate is a plant nutrient, being the end product of the oxidation of ammonia (NH_3) and nitrite (NO_2). As nitrates are produced by decay of plant, animal and human wastes, pollution of water with nitrate is typically found wherever intensive land use activities take place and nitrate-nitrogen concentrations exceeding 20mg/l are a common occurrence in groundwater. Methods to remove nitrate from water include ion-exchange, reverse osmosis, and biological reduction (denitrification) using a carbon source.

Ammonia/Ammonium

Nitrates (NO_3) and Nitrites (NO_2) occur together in the environment and interconvert readily, depending on the redox state of the water (reducing or oxidising conditions). Ammonia (NH_3) and Ammonium (NH_{4+}) also interconvert readily and their relative proportions of inter-conversion are controlled by water temperature and pH-levels. Inorganic nitrogen is primarily of concern in the aquatic habitat due to its stimulatory effect on aquatic plants and algae and due to the toxicity of ammonia to aquatic life. Ammonia affects the respiratory systems of many aquatic animals, either by inhibiting cellular metabolism or by decreasing oxygen permeability of cell membranes. The methods employed to remove ammonia from water, called air stripping, utilises the characteristic that the toxic forms of ammonia are volatile and predominate at a pH of around 11; so by artificially raising the pH to these levels, the ammonia escapes in the gaseous phase.

Sodium (Na)

The predominant effect of sodium at the concentration usually found in fresh water is aesthetic and usually together with chloride, sodium imparts a salty taste to water. Excessive intake of sodium salts in babies can strain kidneys and the heart, while leading to serious disturbances of salt imbalance regarding water retention. Crops irrigated by water containing high sodium or SAR levels are exposed not only to the root zone sodium, but also to the absorption directly through leaves. Effects of sodium and SAR include leaf burn, scorch and dead tissue along the outside edges of leaves. The crop quality is

also affected by sodium-induced leaf injury, especially where leaves are the marketed product and where restrictions on the sodium content of the final product exists.

Sulphate

The presence of sulphate in drinking water can cause noticeable taste defects, and very high levels might cause a laxative effect in unaccustomed consumers. Taste impairment varies with the nature of the associated cation; taste thresholds have been found to range from 250 mg/l for sodium sulphate to 1 000 mg/l for calcium sulphate. It is generally considered that taste impairment is minimal at levels below 250 mg/l.

Turbidity

Turbidity is defined as the light-scattering ability of water, and is the measurement of the cloudiness or muddiness of water. Turbidity does note health effects per se, but is an indicator of microbiological water quality and of inefficient water treatment. As elevated turbidities are often associated with the possibility of microbiological contamination, sensitive groups affected will most possible infants under the age of 2. Thus, depending on the nature of the origin of suspended matter causing turbidity, there may be associated health effects. Serious health effect typically occurs under a turbidity greater that fifty NTU (>50 NTU).

Bacteria

Coliforms are used as indicators of the presence of faecal pollution, and thus the possible presence of disease-causing organisms, such as bacteria, viruses or parasites which may give rise to gastro-intestinal diseases typically characterized by diarrhoea, and sometimes fever and other secondary complications. Faecal coliforms, more specifically *Escherichia coli*, are the most common bacterial indicators of faecal pollution by warm blooded animals. If water is consumed, high coliform counts pose health risks in all users and specifically sensitive users. When crops, especially crops of which the leaves (e.g. lettuce, cabbage, spinach) or underground parts (e.g. potatoes, beetroot, carrots) are consumed, are irrigated with water containing high coliform counts, the risk remains that the consumer of the crop can contract gastro-intestinal diseases.

7.6 CONCLUSION AND ASPECTS TO CONSIDER

The scope of work performed at the Leeuwpan Coal Mine is as per WUL requirements as listed in this report. This report aims to highlight the conditions requirements of the WUL as well as aspects that are to be considered in order to improve compliance of the IWUL.

During the monitoring period samples LSW06, LSW07, LSW08, LSW12, WP01, RD1, KR03, KR04, OG PIT, OH PIT, OJ PIT, OM PIT, WLV PIT, LWP-SP-W, OWM-PIT and PIET-SCHUTTE could not be obtained during the monitoring period.

Based on the historical analysed parameters and data, the potable water poses a risk for infection due to the elevated Heterotrophic Plate Counts as well as health risks. It is strongly advised that the water not be used for potable or domestic purposes and “no-drinking signs” be present as current implemented.

Exceedances of Ca, Mg, Turbidity, DOC and indicated presence of Oil and Grease were presented at the receiving environment. From the results it is evident that the majority of the receiving environment monitoring localities presented overall fair condition with general low salinity content.

The process water samples revealed compliance to the stipulated WUL limits, except for the ODN-PIT monitoring point which exceeded the limit for *E.coli*. Discharge of the process water into the receiving environment is prohibited according to the General Authorisation (Section 21f and h, 2013) as it could have limiting effects on the receiving water environment. Note that regular maintenance on process water facilities linings and transfer pipes are vital for water resource protection.

Representative samples related to October 2020 could not be obtained thus the final effluent from LWP-SP-P historically recorded non-compliant to the set Ammonia Wastewater WUL limits, while exceedances related to the General Authorisation limits included Suspended Solids, Ammonia and Chemical Oxygen Demand.

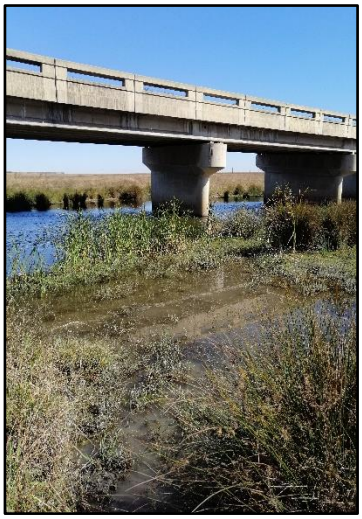
During the monthly monitoring period, the majority of the localities presented relatively stable conditions compared to September 2020, with fluctuation in bacteriological content noted.

Aspects to consider:

- The potable water poses a risk for infection based on the elevated bacteriological and thus it is strongly advised that the water be treated and filters regularly disinfected and cleaned as the high counts may be attributed to biofilms, however warning signs have been implemented indicating water is unfit for human consumption;
- Clean and dirty stormwater must be separated as reasonably possible;
- All waste water be contained and not released into the receiving environment;
- All spills and incidents be reported to the SHEQ manager; and
- Immediate reporting of any polluting or potentially polluting incidents be implemented.

APPENDIX A – SAMPLING REGISTER

Surface Water Monitoring Localities:

Sample ID	Details	Photo
WP01	**Latitude (DD):** S26.17799 **Longitude (DD):** E28.70221 **Description:** Bronkhorstspruit tributary, upstream **Frequency:** Monthly **Sample Date:** 02/10/2020 **Sampling status:** Dry **Time:** N/A	
WP02	**Latitude (DD):** S26.15510 **Longitude (DD):** E28.70260 **Description:** Bronkhorstspruit tributary, downstream **Frequency:** Monthly **Sample Date:** 02/10/2020 **Sampling status:** Sampled **Time:** 09:26	

Sample ID	Details	Photo
LSW03	**Latitude (DD):** S26.16279 **Longitude (DD):** E28.76881 **Description:** Bronkhorstspruit at Delmas Silica, downstream **Frequency:** Monthly **Sample Date:** 02/10/2020 **Sampling status:** Sampled **Time:** 10:23	
LSW05	**Latitude (DD):** S26.13750 **Longitude (DD):** E28.75700 **Description:** Bronkhorstspruit, downstream **Frequency:** Monthly **Sample Date:** 02/10/2020 **Sampling status:** Sampled **Time:** 09:53	
LSW06	**Latitude (DD):** S26.14390 **Longitude (DD):** E28.79550 **Description:** Weltevredenspruit, upstream **Frequency:** Monthly **Sample Date:** 02/10/2020 **Sampling status:** Dry **Time:** N/A	

Sample ID	Details	Photo
LSW07	**Latitude (DD):** S26.18860 **Longitude (DD):** E28.77635 **Description:** Bronkhorstspruit, upstream **Frequency:** Monthly **Sample Date:** 02/10/2020 **Sampling status:** Dry **Time:** N/A	
LSW08	**Latitude (DD):** S26.23022 **Longitude (DD):** E28.76264 **Description:** Bronkhorstspruit, upstream of block OI **Frequency:** Monthly **Sample Date:** 02/10/2020 **Sampling status:** Dry **Time:** N/A	
LSW12	**Latitude (DD):** S26.13610 **Longitude (DD):** E28.76410 **Description:** Downstream of River Diversion 2, between RD2 and LSW05 **Frequency:** Monthly **Sample Date:** 02/10/2020 **Sampling status:** Dry **Time:** N/A	

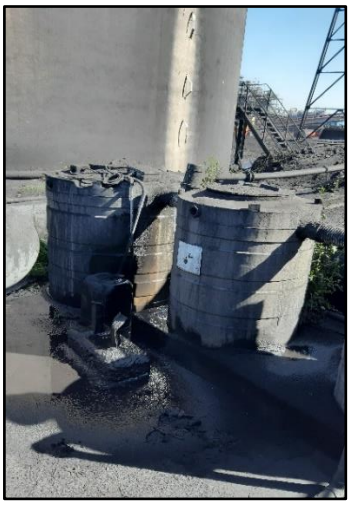
Sample ID	Details	Photo
LSW13	**Latitude (DD):** S26.14380 **Longitude (DD):** E28.77560 **Description:** Water from Stuart Coal **Frequency:** Monthly **Sample Date:** 02/10/2020 **Sampling status:** Sampled **Time:** 10:40	
RD1	**Latitude (DD):** S26.14930 **Longitude (DD):** E28.76450 **Description:** Bronkhorstspruit at haul road **Frequency:** Monthly **Sample Date:** 02/10/2020 **Sampling status:** Dry **Time:** N/A	
Process Monitoring Localties		
KR01A	**Latitude (DD):** S26.18087 **Longitude (DD):** E28.72995 **Description:** Kenbar Return Water Dam **Frequency:** Monthly **Sample Date:** 02/10/2020 **Sampling status:** Sampled **Time**: 11:46	

Sample ID	Details	Photo
KR03	**Latitude (DD):** S26.18197 **Longitude (DD):** E28.73827 **Description:** Downstream of workshop oil separator sump **Frequency:** Monthly **Sample Date:** 02/10/2020 **Sampling status:** Dry **Time:** N/A	
KR04	**Latitude (DD):** S26.18672 **Longitude (DD):** E28.73381 **Description:** Marsh area next to workshop road **Frequency:** Monthly **Sample Date:** 02/10/2020 **Sampling status:** Dry **Time:** N/A	
LSW09	**Latitude (DD):** S26.16601 **Longitude (DD):** E28.72541 **Description:** Pollution Control Dam (PCD) **Frequency:** Monthly **Sample Date:** 02/10/2020 **Sampling status:** Sampled **Time:** 11:03	

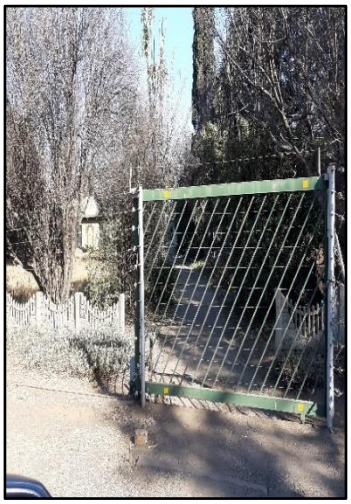
Sample ID	Details	Photo
ODN_PIT	**Latitude (DD):** S26.17122 **Longitude (DD):** E28.72381 **Description:** OD Pit Water **Frequency:** Monthly **Sample Date:** 02/10/2020 **Sampling status:** Sampled **Time:** 11:16	
OG_PIT	**Latitude (DD):** S26.17119 **Longitude (DD):** E28.73397 **Description:** OG Pit Water (Backfilled pit) **Frequency:** Monthly **Sample Date:** 02/10/2020 **Sampling status:** Rehabilitated **Time:** N/A	
OH_PIT	**Latitude (DD):** S26.16698 **Longitude (DD):** E28.75338 **Description:** OH Pit Water (Backfilled pit) **Frequency:** Monthly **Sample Date:** 02/10/2020 **Sampling status:** Rehabilitated **Time:** N/A	

Sample ID	Details	Photo
OJ_PIT	**Latitude (DD):** S26.16854 **Longitude (DD):** E28.74505 **Description:** OJ Pit Water **Frequency:** Monthly **Sample Date:** 02/10/2020 **Sampling status:** Rehabilitated **Time:** N/A	
OM_PIT	**Latitude (DD):** S26.17278 **Longitude (DD):** E28.74875 **Description:** OM Pit Water **Frequency:** Monthly **Sample Date:** 02/10/2020 **Sampling status:** Rehabilitated **Time:** N/A	
OWM_PIT	**Latitude (DD):** S26.14440 **Longitude (DD):** E28.79241 **Description:** OWM (Moabsvelden) Pit Water **Frequency:** Monthly **Sample Date:** 02/10/2020 **Sampling status:** Dry **Time:** N/A	

Sample ID	Details	Photo
WLV_PIT	**Latitude (DD):** S26.12888 **Longitude (DD):** E28.76050 **Description:** Weltevreden Pit **Frequency:** Monthly **Sample Date:** 02/10/2020 **Sampling status:** Rehabilitated **Time:** N/A	
WP04	**Latitude (DD):** S26.17234 **Longitude (DD):** E28.70640 **Description:** New Witklip Return Water Dam **Frequency:** Monthly **Sample Date:** 02/10/2020 **Sampling status:** Sampled **Time:** 11:29	

Effluent Monitoring Localties		
LWP_SP_P	**Latitude (DD):** S26.1716 **Longitude (DD):** E28.7302 **Description:** Final effluent from septic tanks at plant **Frequency:** Monthly **Sample Date:** 02/10/2020 **Sampling status:** Not Active **Time:** N/A	
LWP_SP_W	**Latitude (DD):** S26.1812 **Longitude (DD):** E28.7396 **Description:** Final effluent at sewage plant behind workshop **Frequency:** Monthly **Sample Date:** 02/10/2020 **Sampling status:** Not access **Time:** N/A	

Potable Monitoring Localities		
LDWST	**Latitude (DD):** S26.18005 **Longitude (DD):** E28.73602 **Description:** Drinking water supply tank **Frequency:** Monthly **Sample Date:** 02/10/2020 **Sampling status:** Sampled **Time:** 11:35	
LLBDW	**Latitude (DD):** S26.16590 **Longitude (DD):** E28.72990 **Description:** Load-out Bay Offices Drinking Water **Frequency:** Monthly **Sample Date:** 02/10/2020 **Sampling status:** Sampled **Time**: 09:39	
LWDL	**Latitude (DD):** S26.17128 **Longitude (DD):** E28.72797 **Description:** Drinking Water at Laboratory **Frequency:** Monthly **Sample Date:** 02/10/2020 **Sampling status:** Sampled **Time:** 11:10	

PIET-SCHUTTE	**Latitude (DD):** S26.14150 **Longitude (DD):** E28.80170 **Description:** Drinking Water on Piet Schutte's Farm **Frequency:** Monthly **Sample Date:** 02/10/2020 **Sampling status:** No water **Time:** N/A	

APPENDIX B – PROBE FIELD MEASUREMENTS

Name	Temp (C)	pH	ORP (REDOX)	DO (% Sat)	DO (mg/L)	EC (uS/cm @25C)	RES (Ohms.cm)	TDS (mg/L)	SAL (PSU)	SSG (st)	Turbidity (NTU)
KR01A	16.23	7.85	13.1	95.3	7.8	2985	402	1940	1.53	0	0
LDWST	16.25	8.13	-13.7	70.7	5.82	691	1739	449	0.29	0	0
LLBDW	15.95	7.45	-45.6	54.6	4.5	2549	474	1656	1.31	0	0
LSW03	16.05	7.91	-24.8	27.8	2.3	509	2369	330	0.21	0	0
LSW05	15.4	7.89	-42.8	98.5	8.29	615	1988	399	0.26	0	0
LSW09	14.93	7.82	4.1	82.5	6.93	2893	428	1880	1.48	0.2	6
LSW13	16.05	7.93	8.3	95.2	7.88	652	1851	423	0.27	0	0
LWDL	16.15	7.75	4.2	91	7.52	3252	370	2113	1.69	0.2	0
ODN-PIT	16.58	7.82	-13.4	77.5	6.31	2880	414	1872	1.48	0	0
WP02	16.78	7.45	-53	60.2	4.91	778	1526	505	0.33	0	0
WP04	15.68	7.99	-2.9	92.2	7.67	2908	419	1890	1.49	0.1	4,6

APPENDIX C – SURFACE WATER GRAPHS

RECEIVING ENVIRONMENT GRAPHS

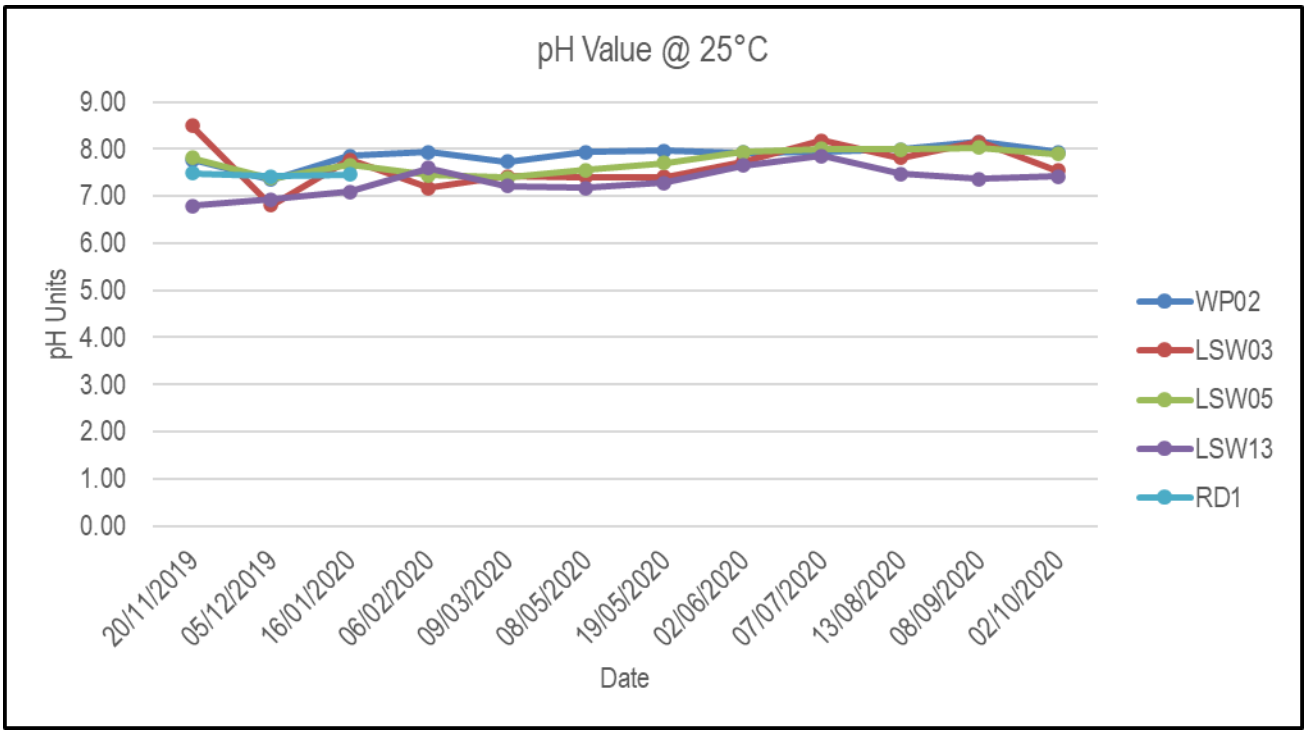


Figure 6: pH value

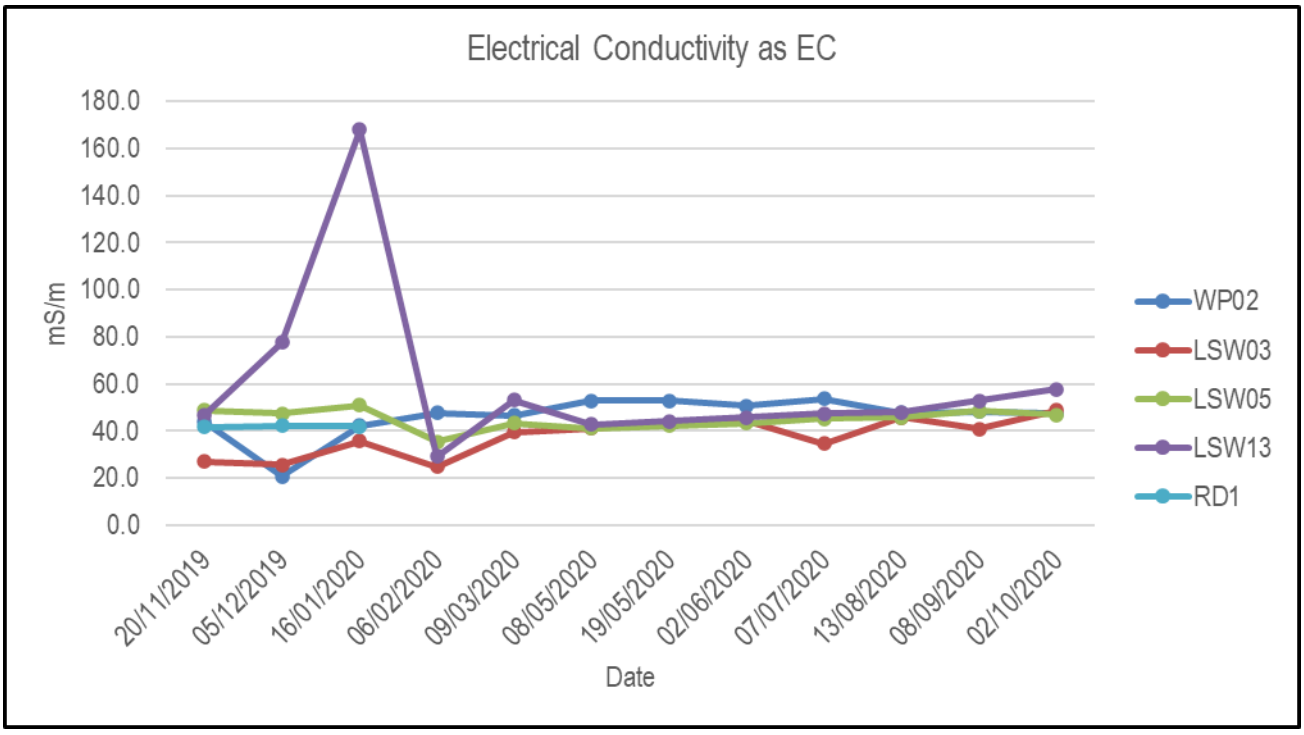


Figure 7: Electrical Conductivity

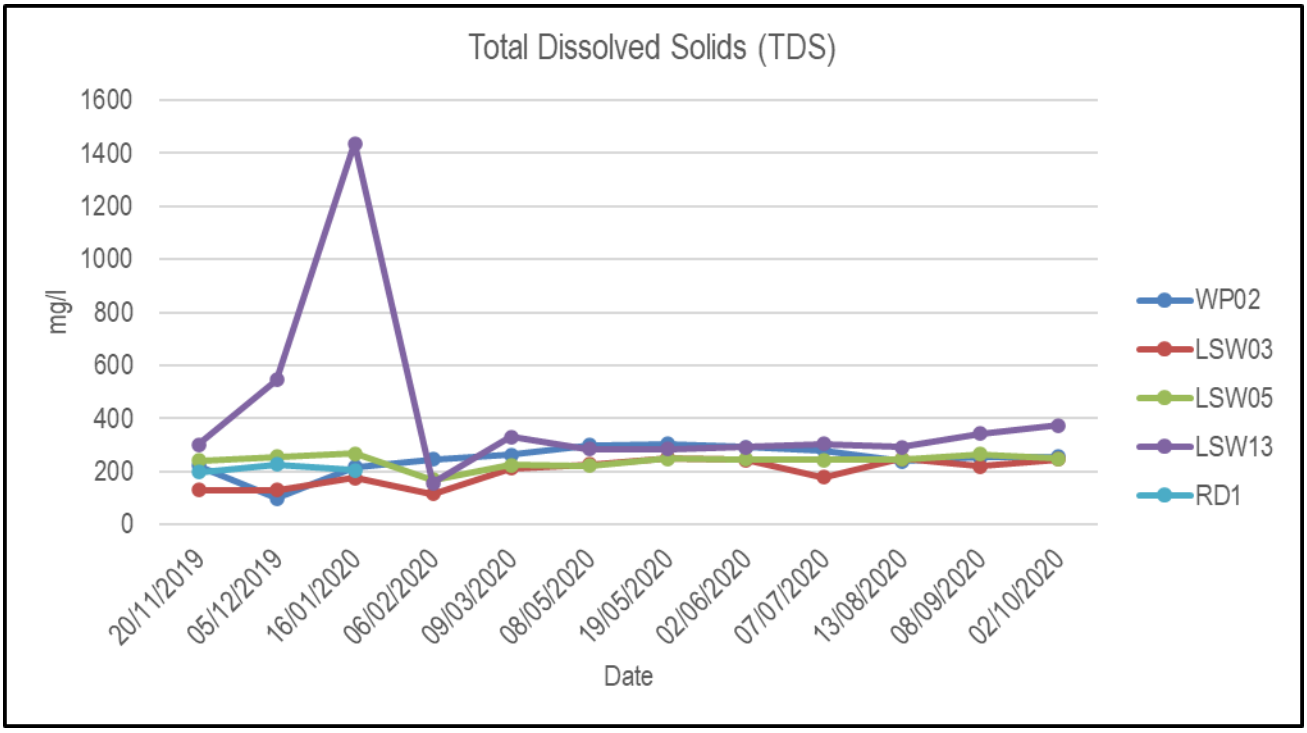


Figure 8: Total Dissolved Solids

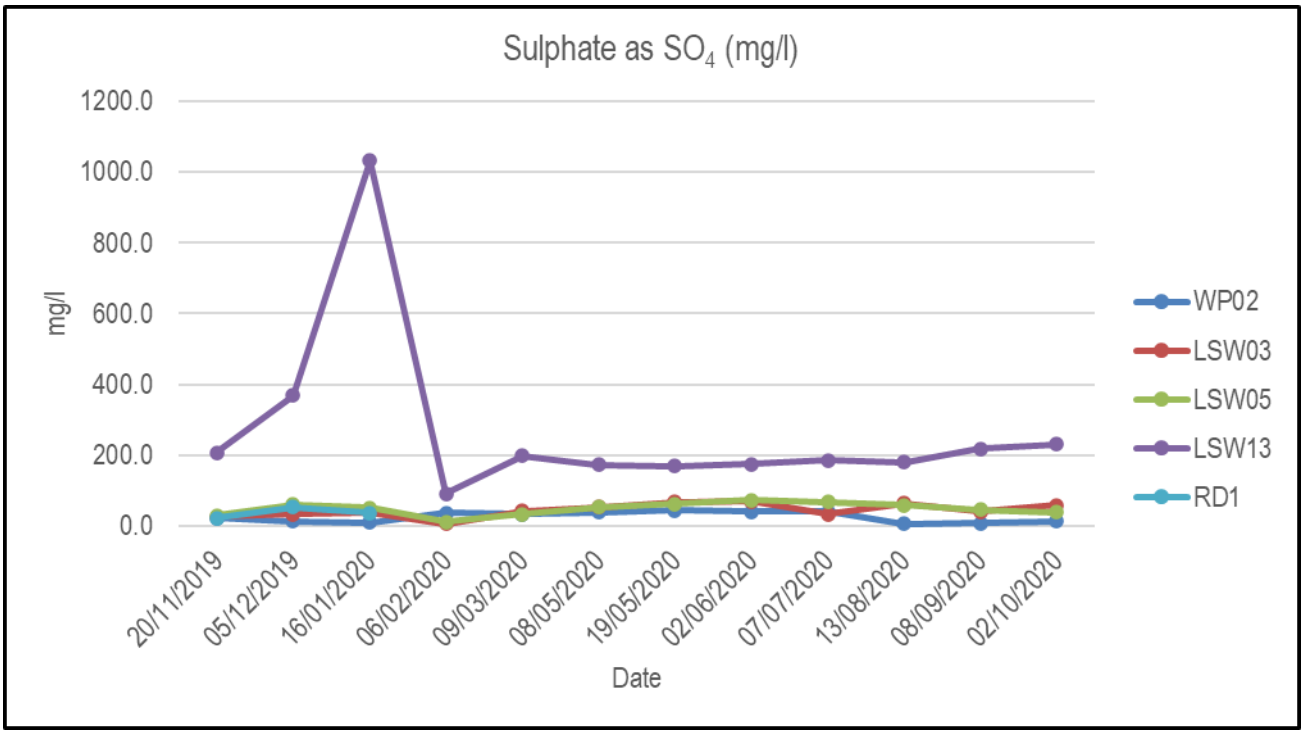


Figure 9: Sulphate

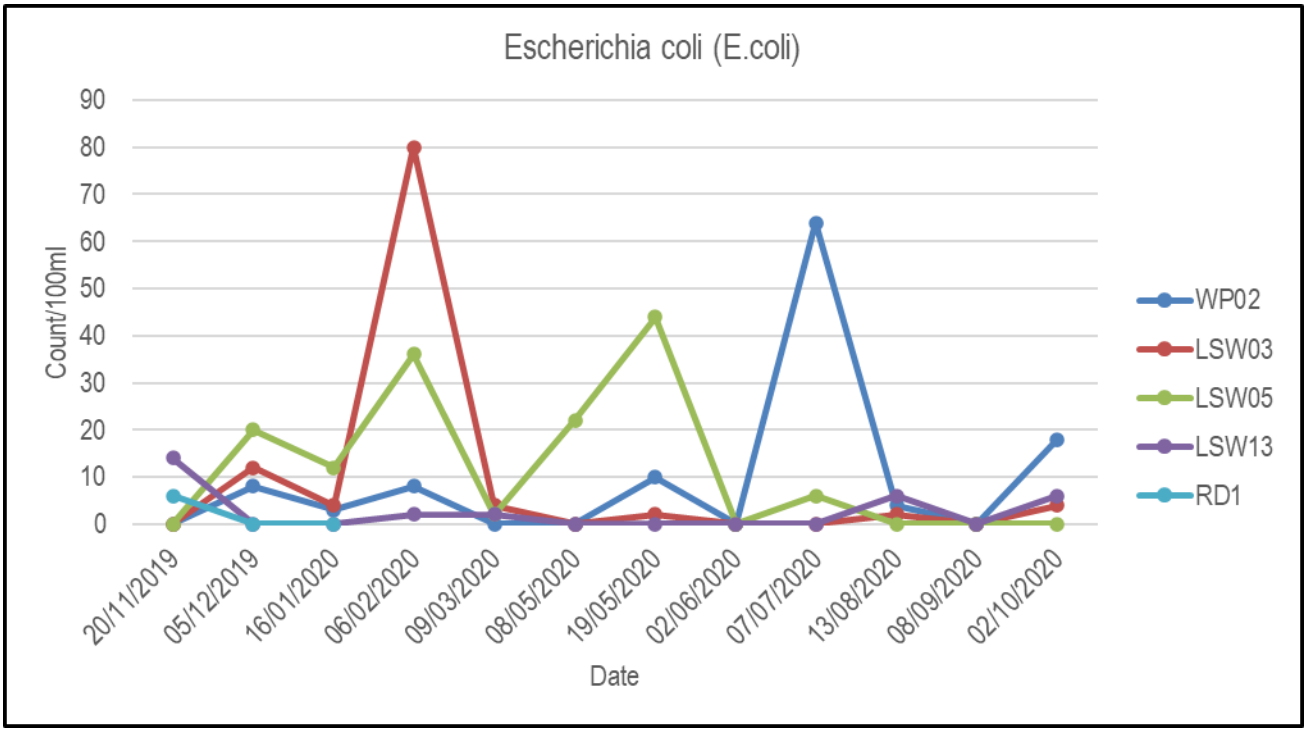


Figure 10: ***Escherichia coli***

PROCESS WATER GRAPHS

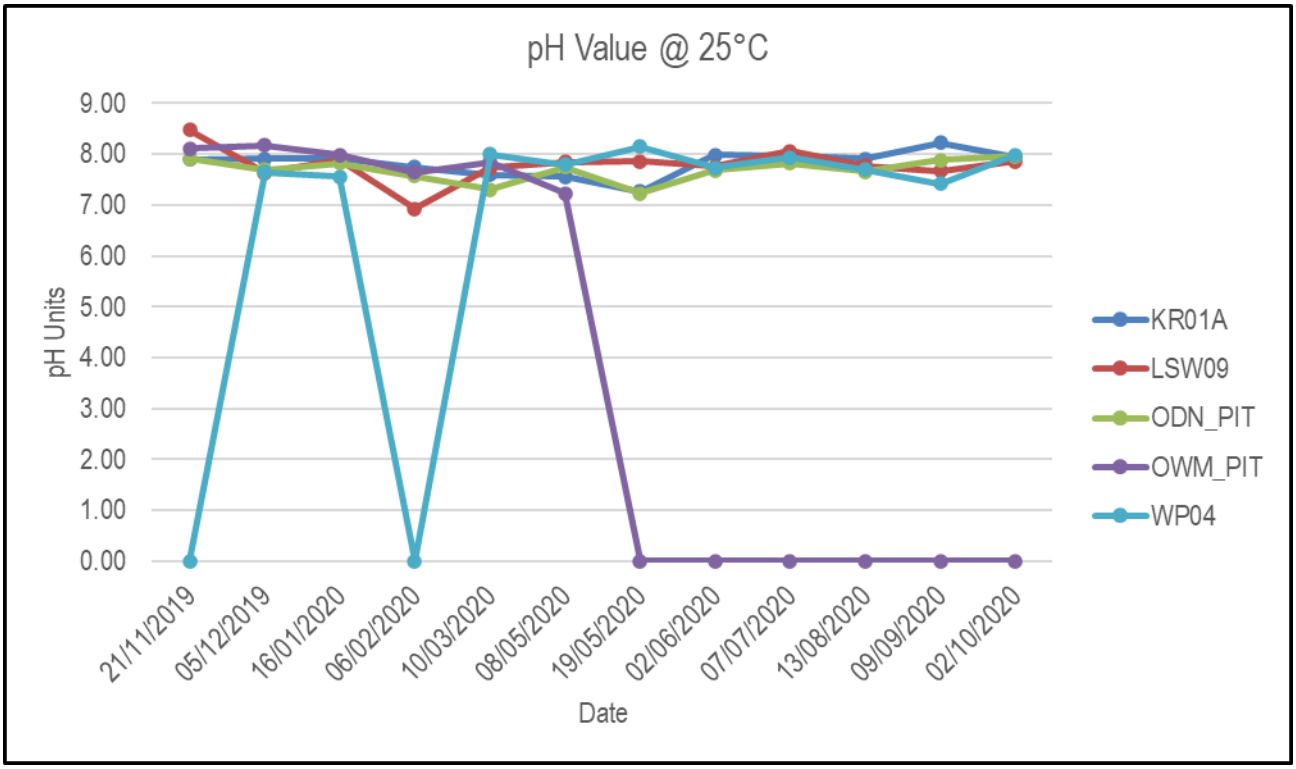


Figure 11: pH value

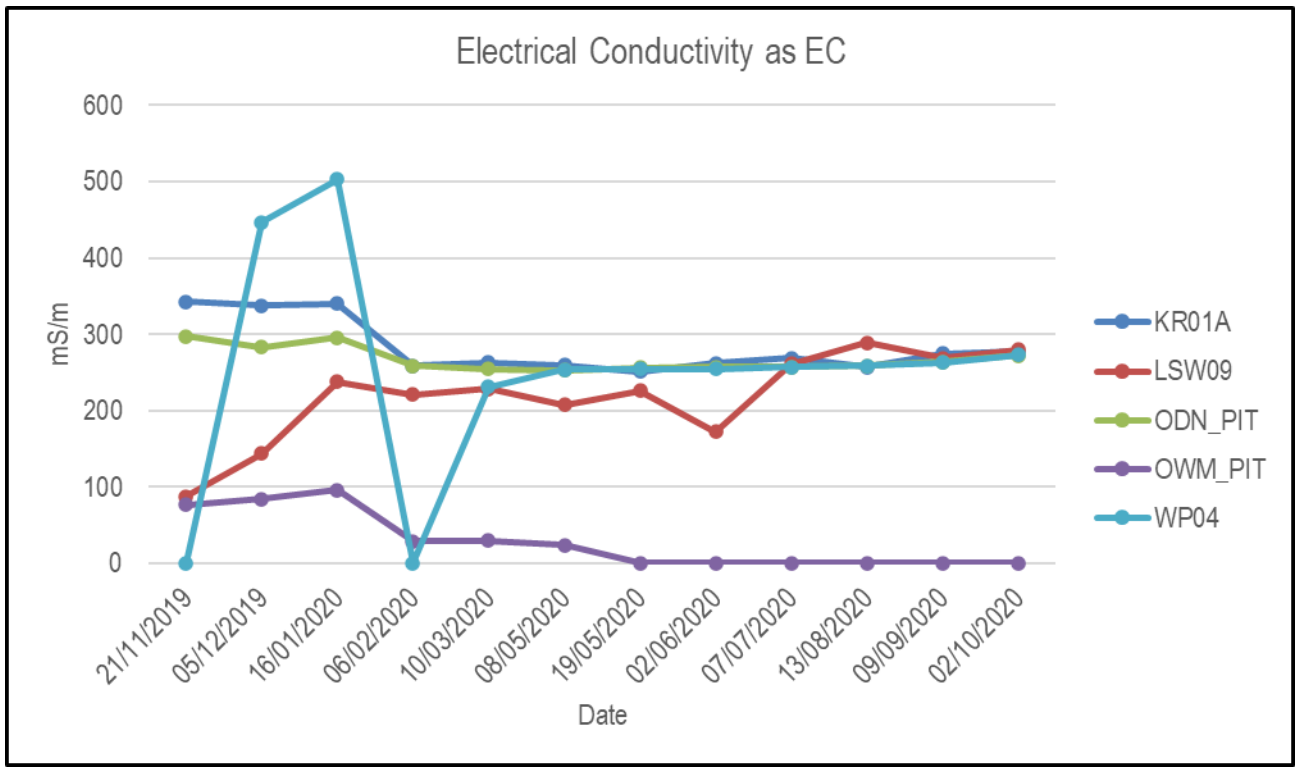


Figure 12: Electrical Conductivity

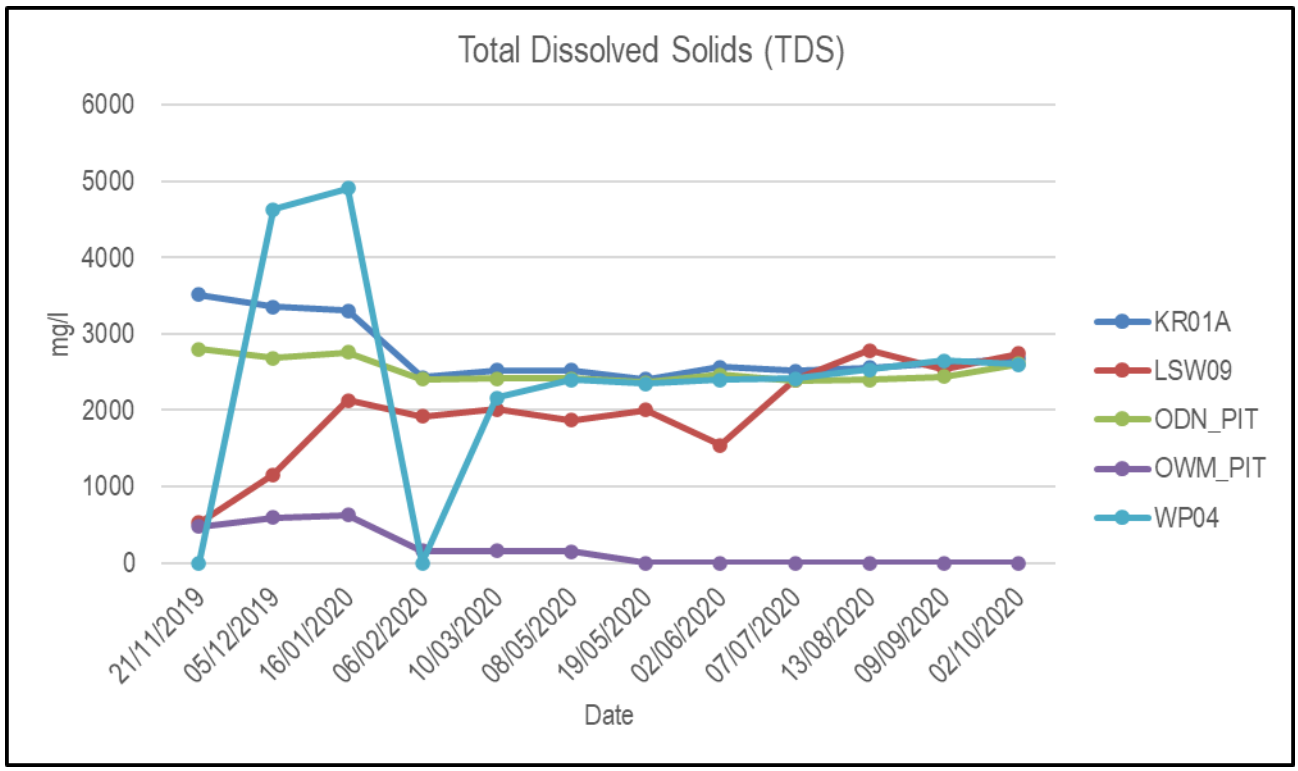


Figure 13: Total Dissolved Solids

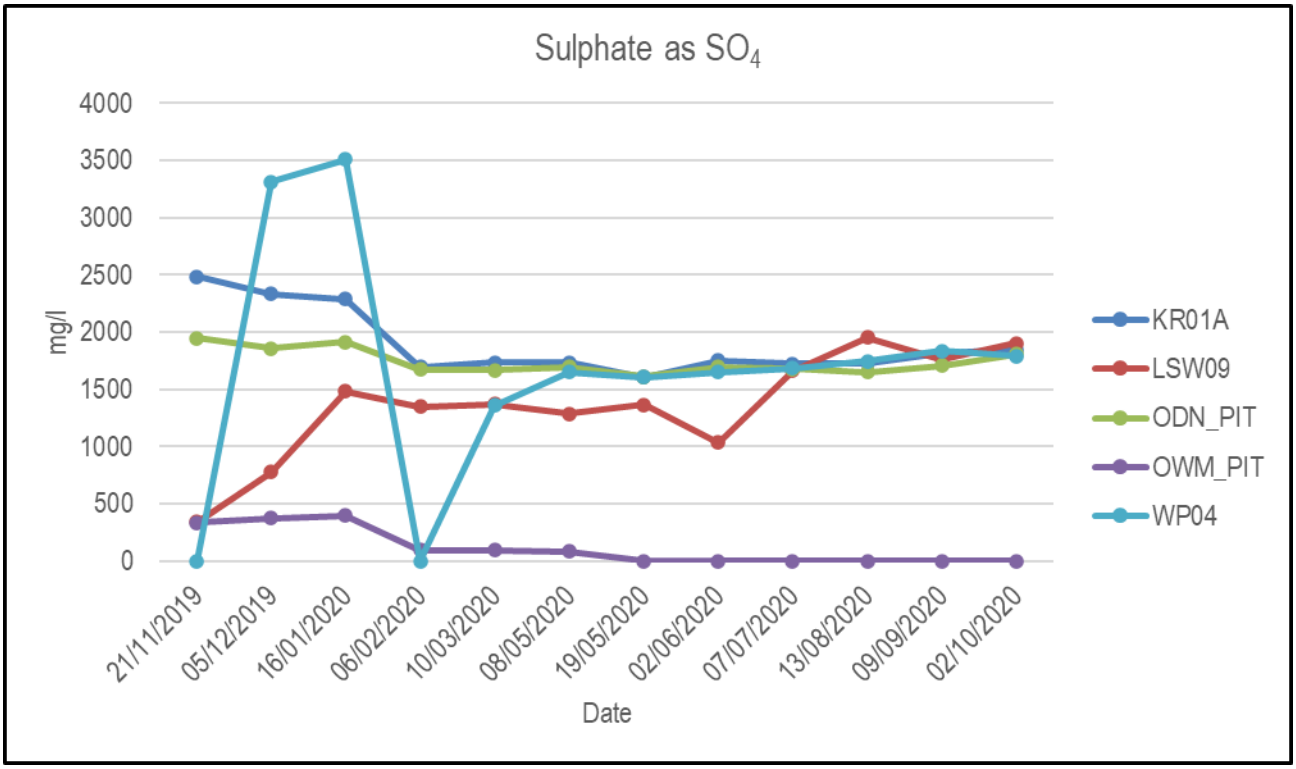


Figure 14: Sulphate

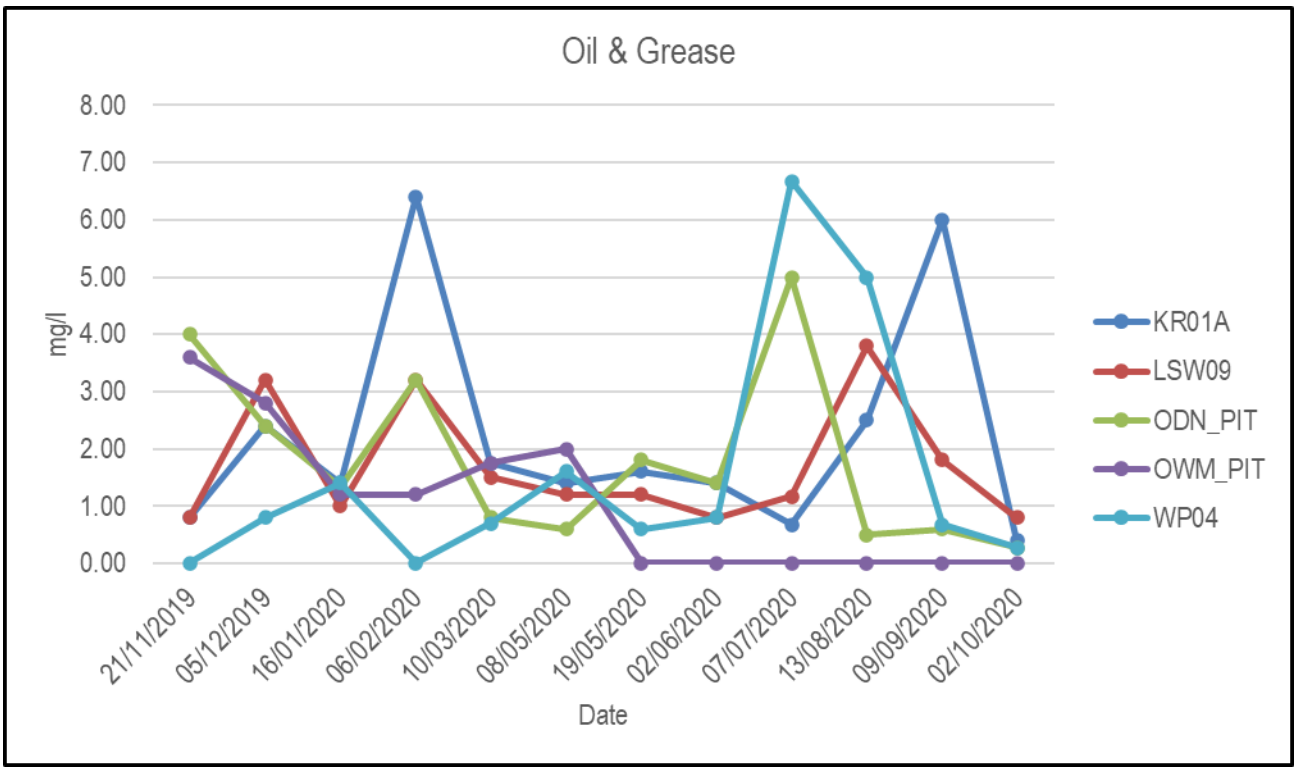


Figure 15: Oil and Grease

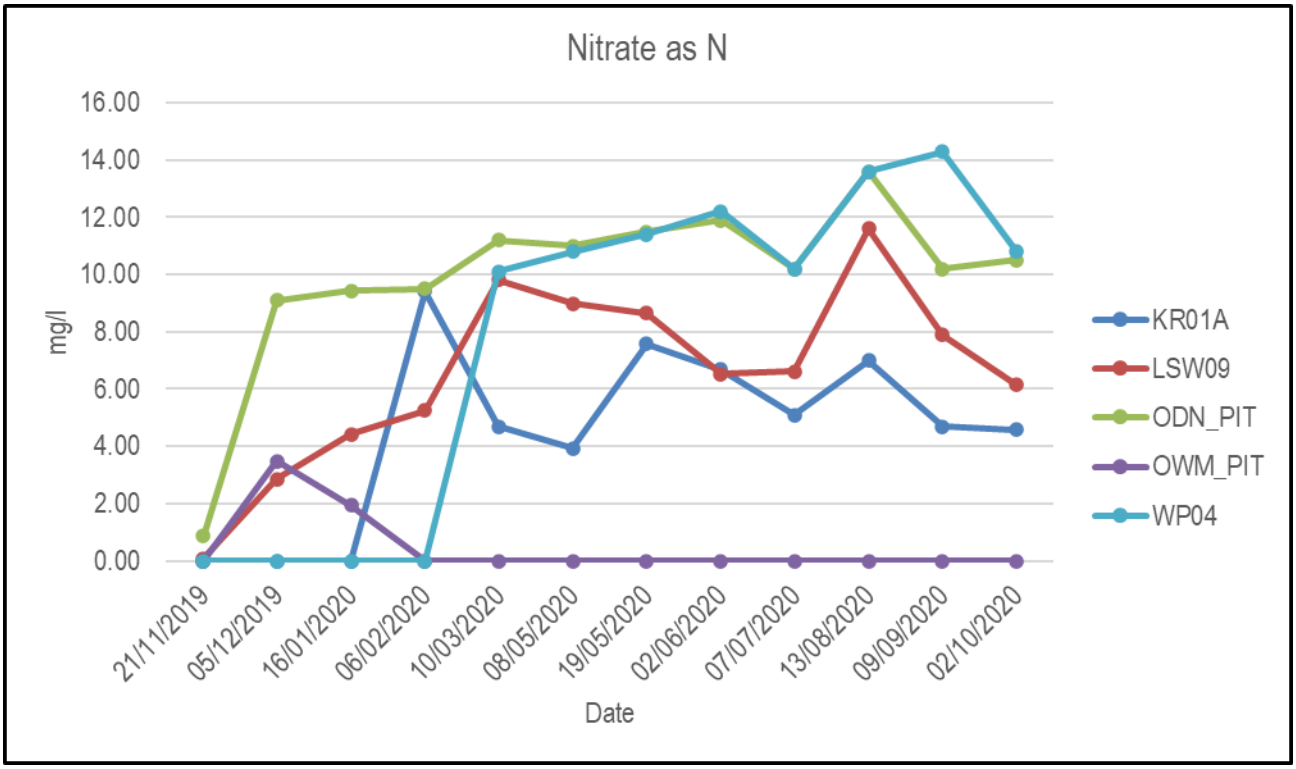


Figure 16: Nitrate

EFFLUENT WATER GRAPHS

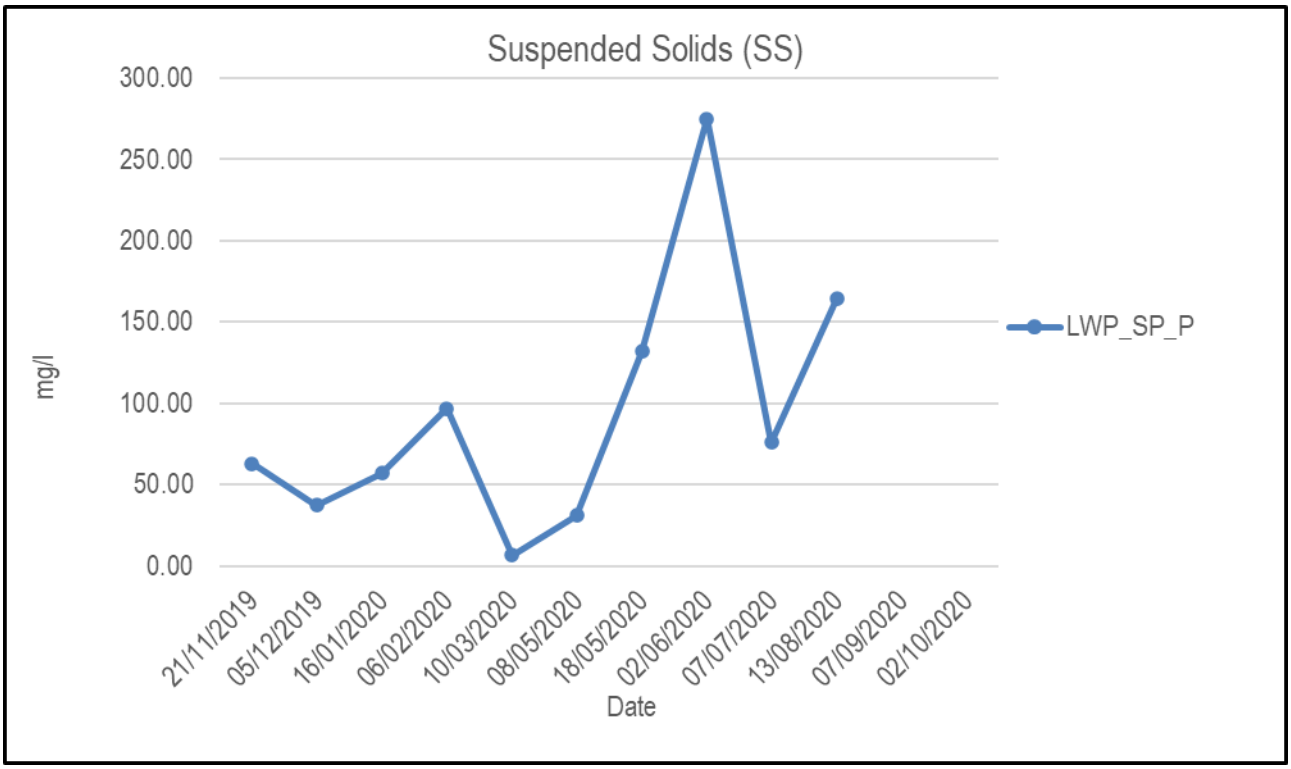


Figure 17: Suspended Solids

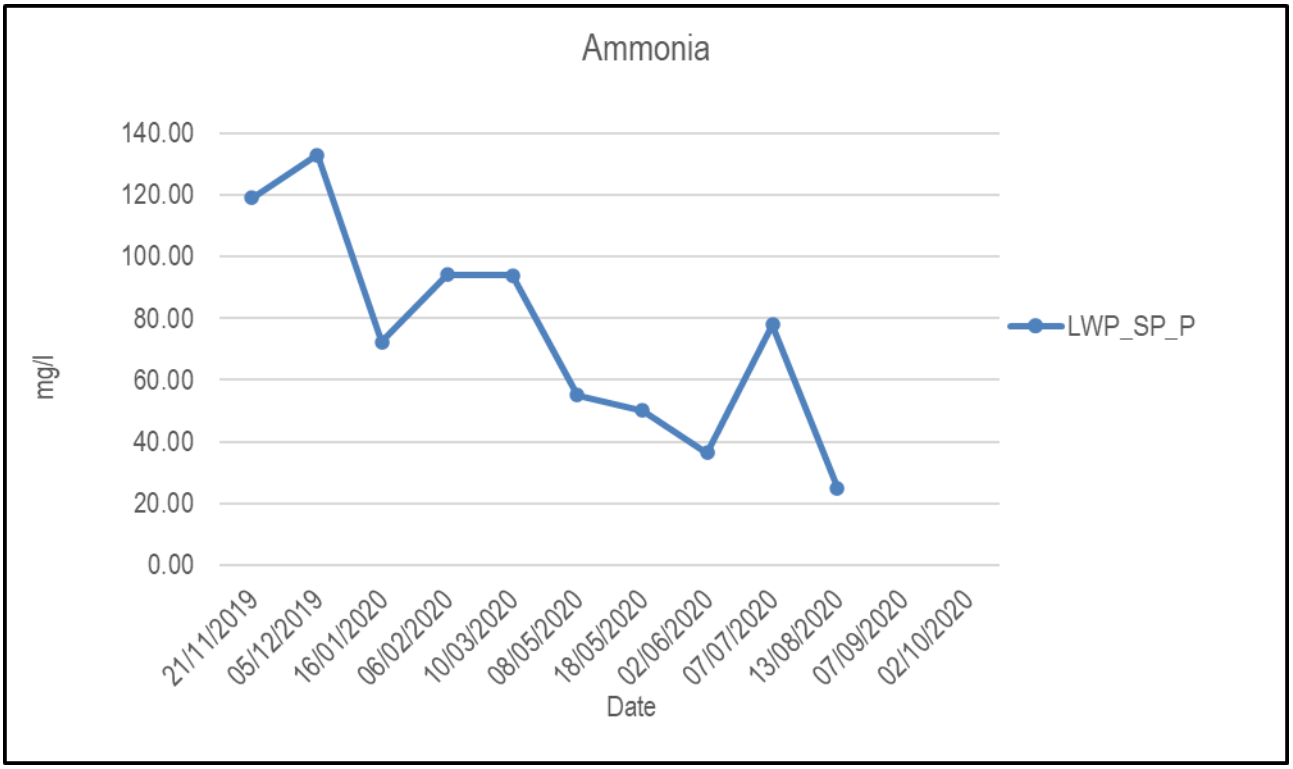


Figure 18: Ammonia

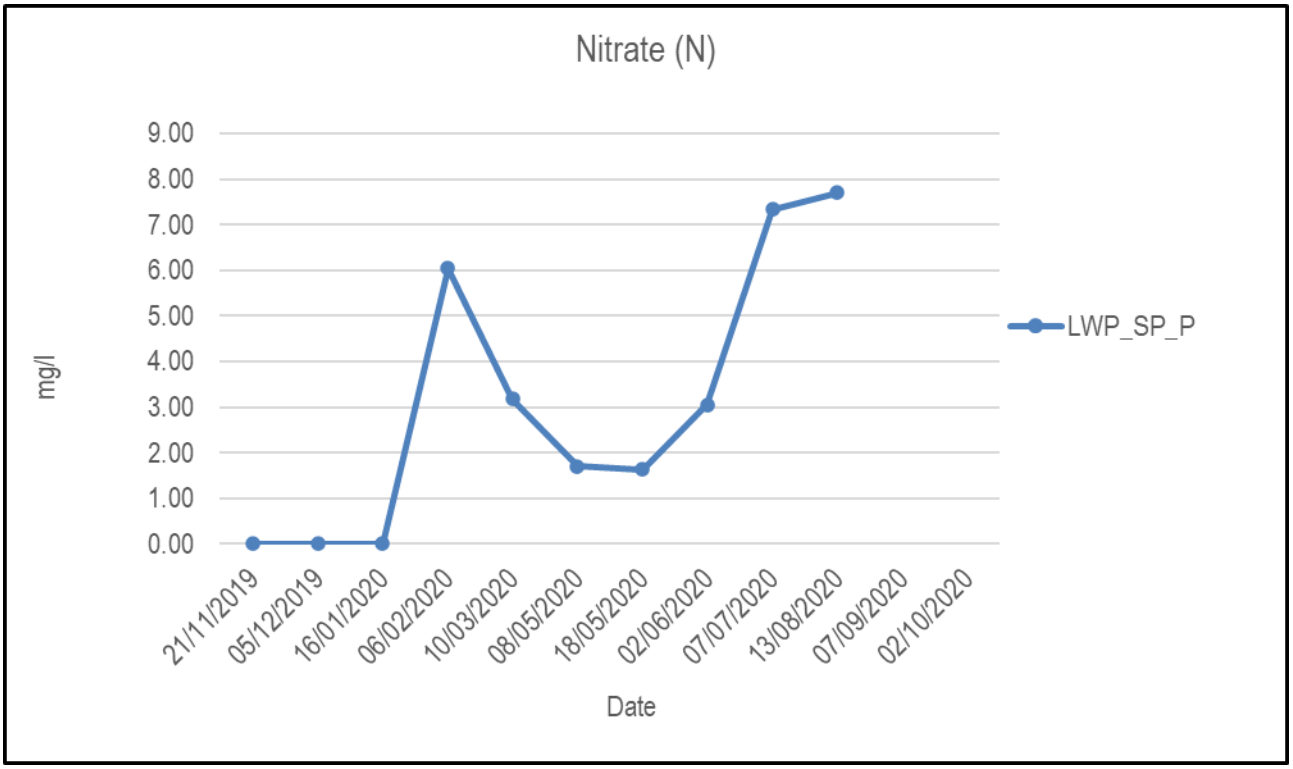


Figure 19: Nitrate

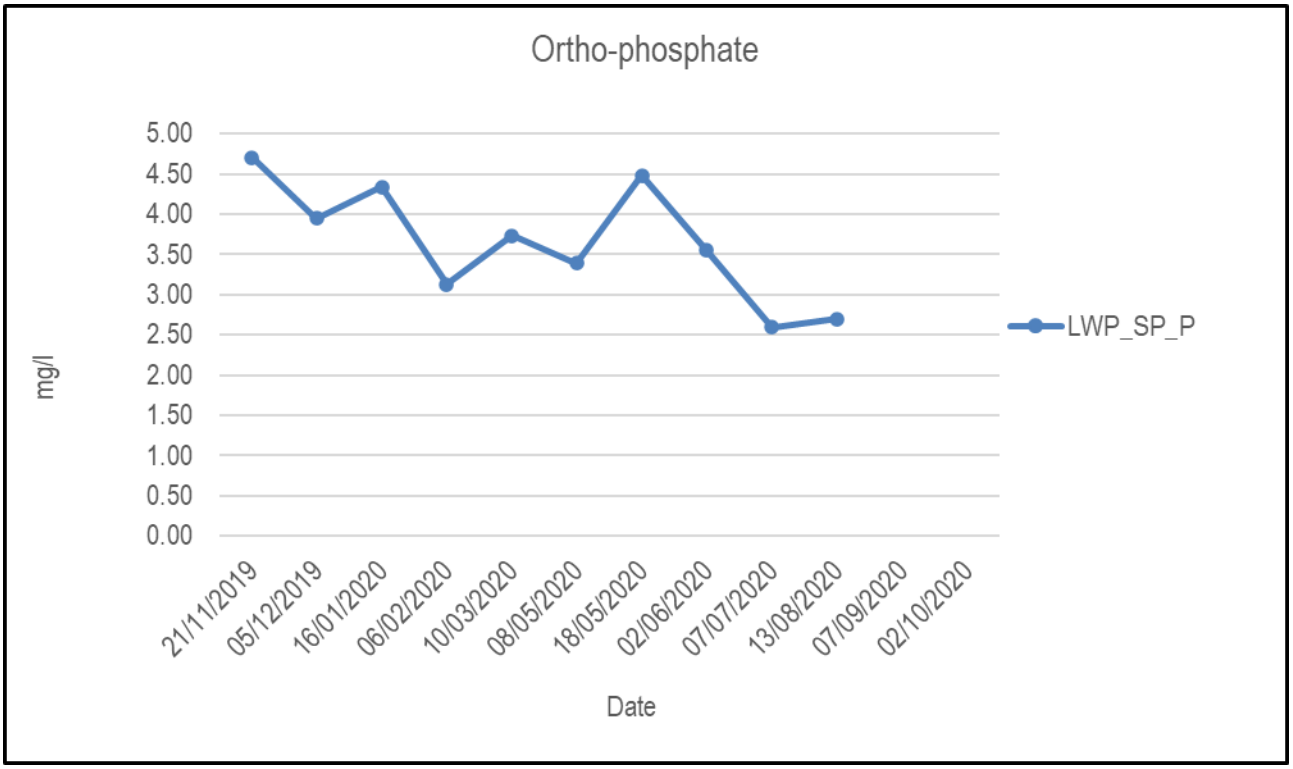


Figure 20: Ortho-Phosphate

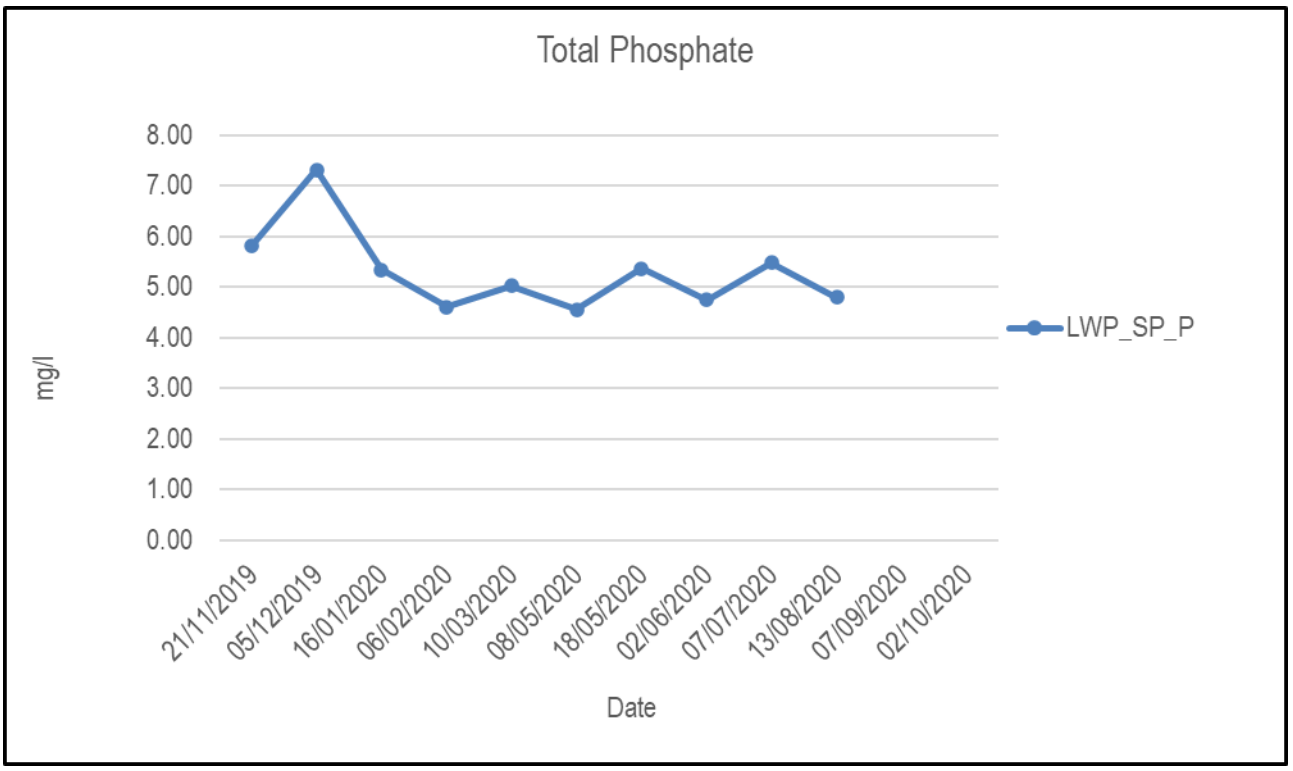


Figure 21: Total Phosphate

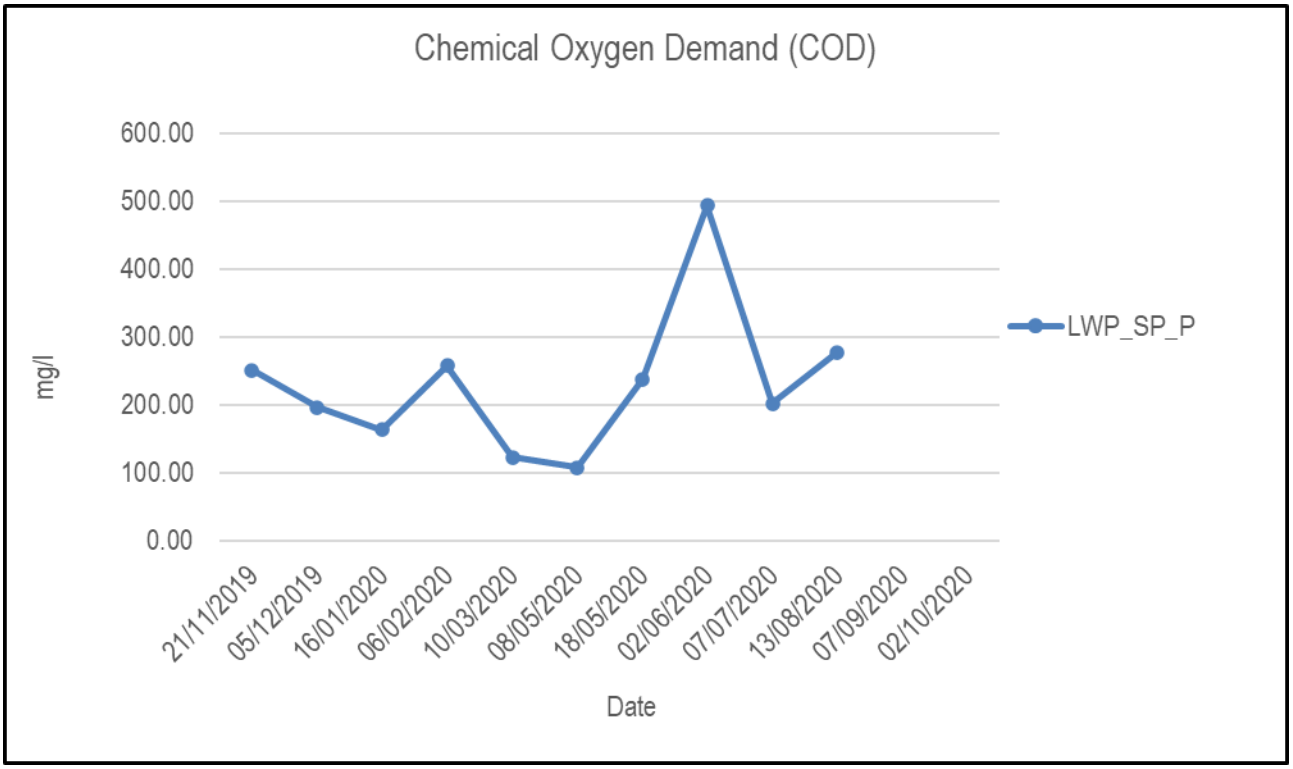


Figure 22: Chemical Oxygen Demand (COD)

POTABLE WATER GRAPHS

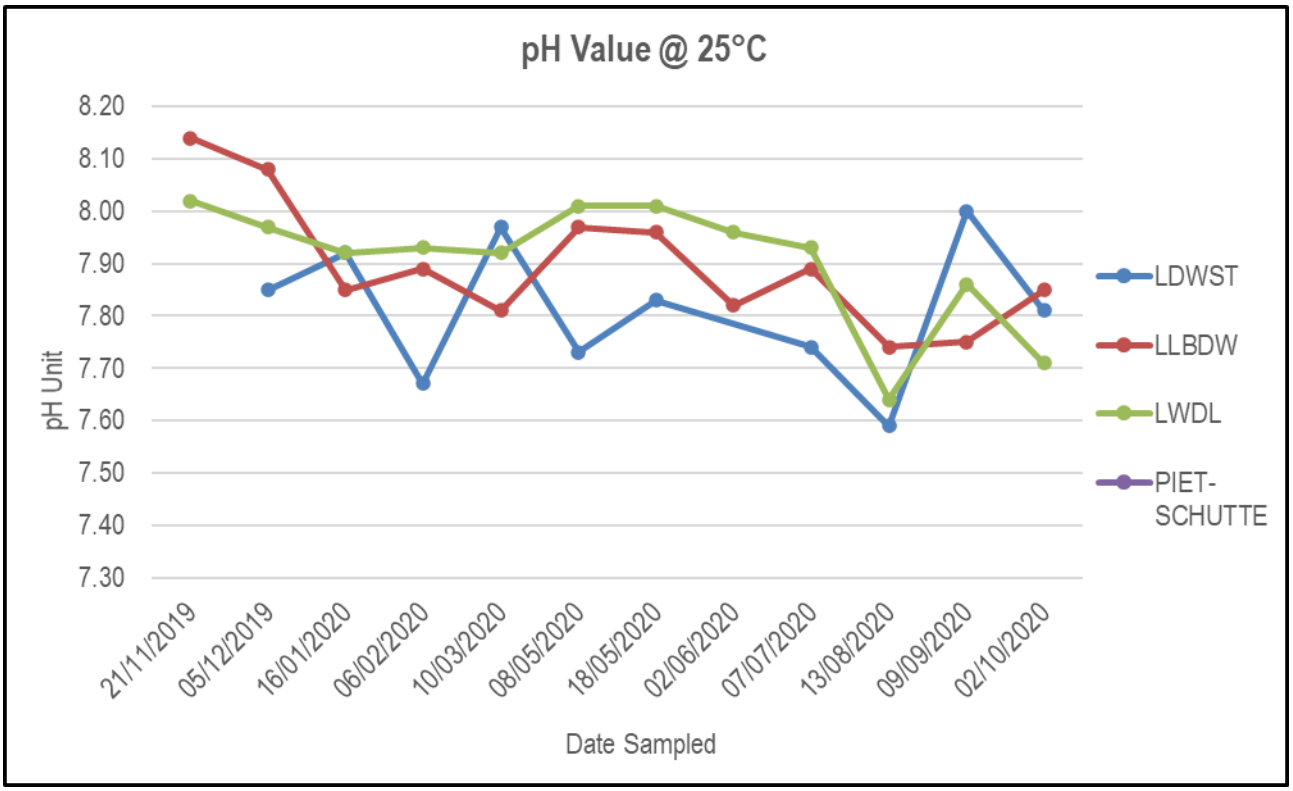


Figure 23: pH value

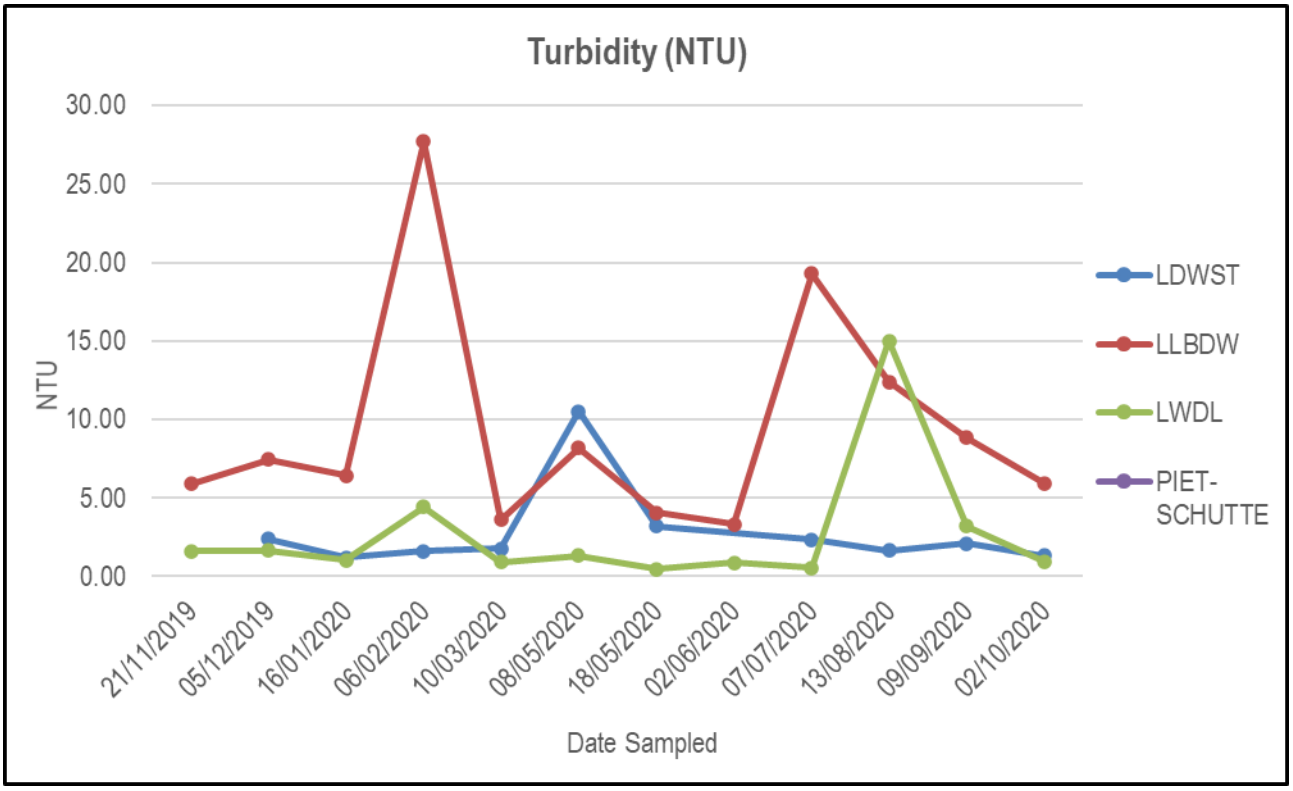


Figure 24: Turbidity

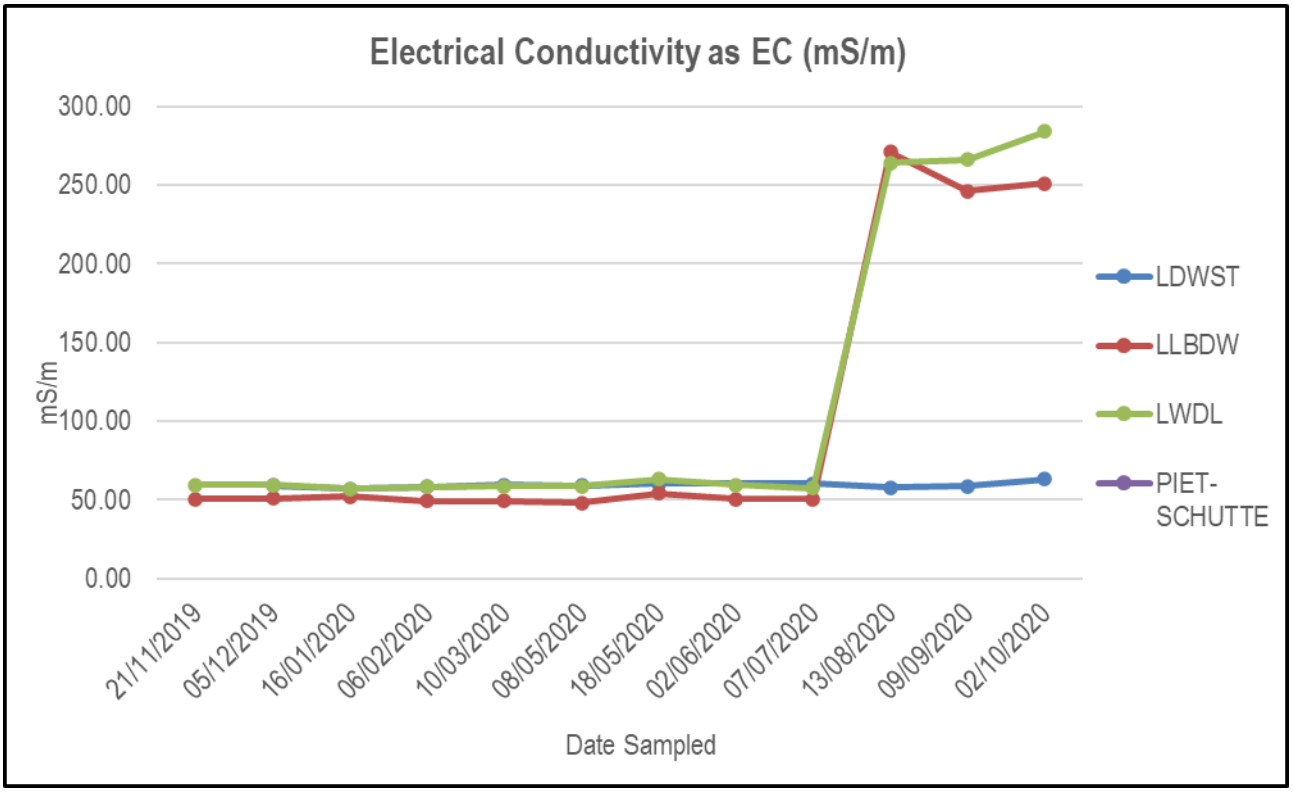


Figure 25: Electrical Conductivity

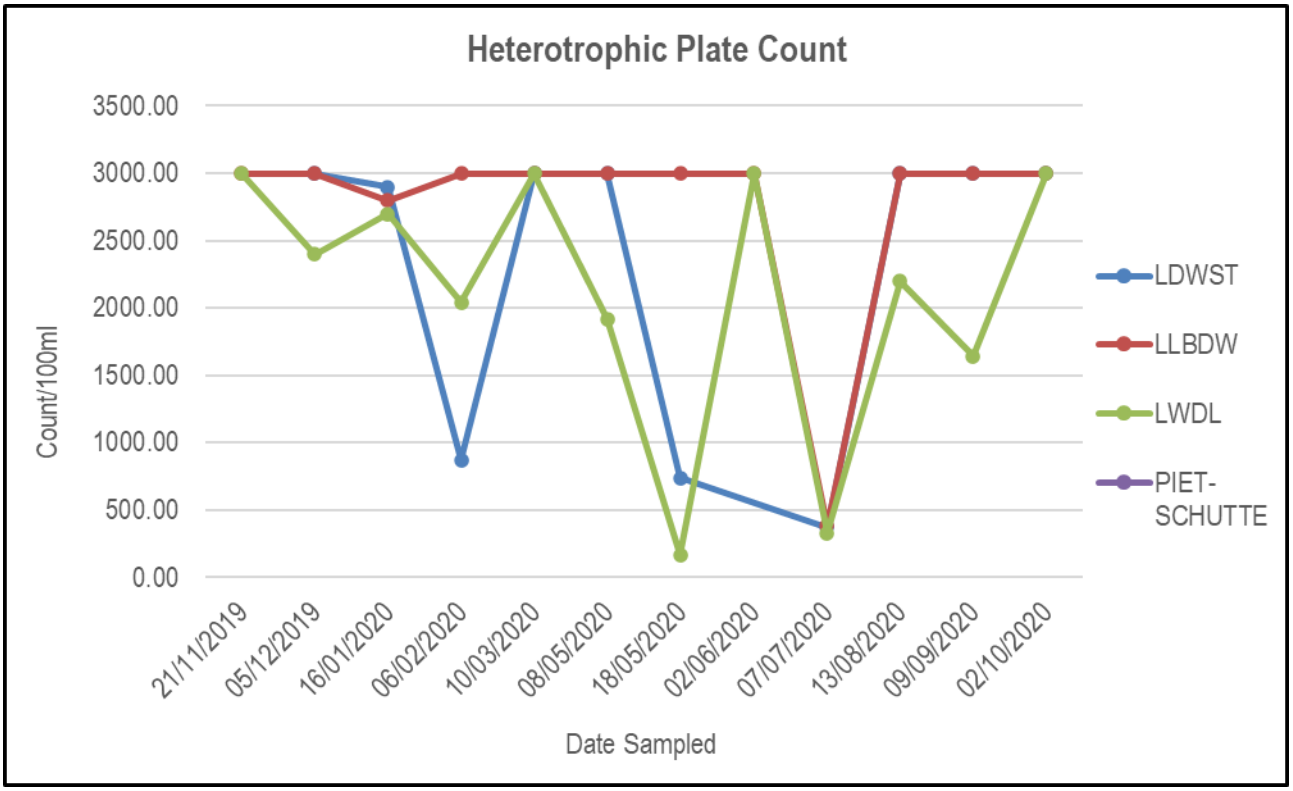


Figure 26: Heterotrophic Plate Count

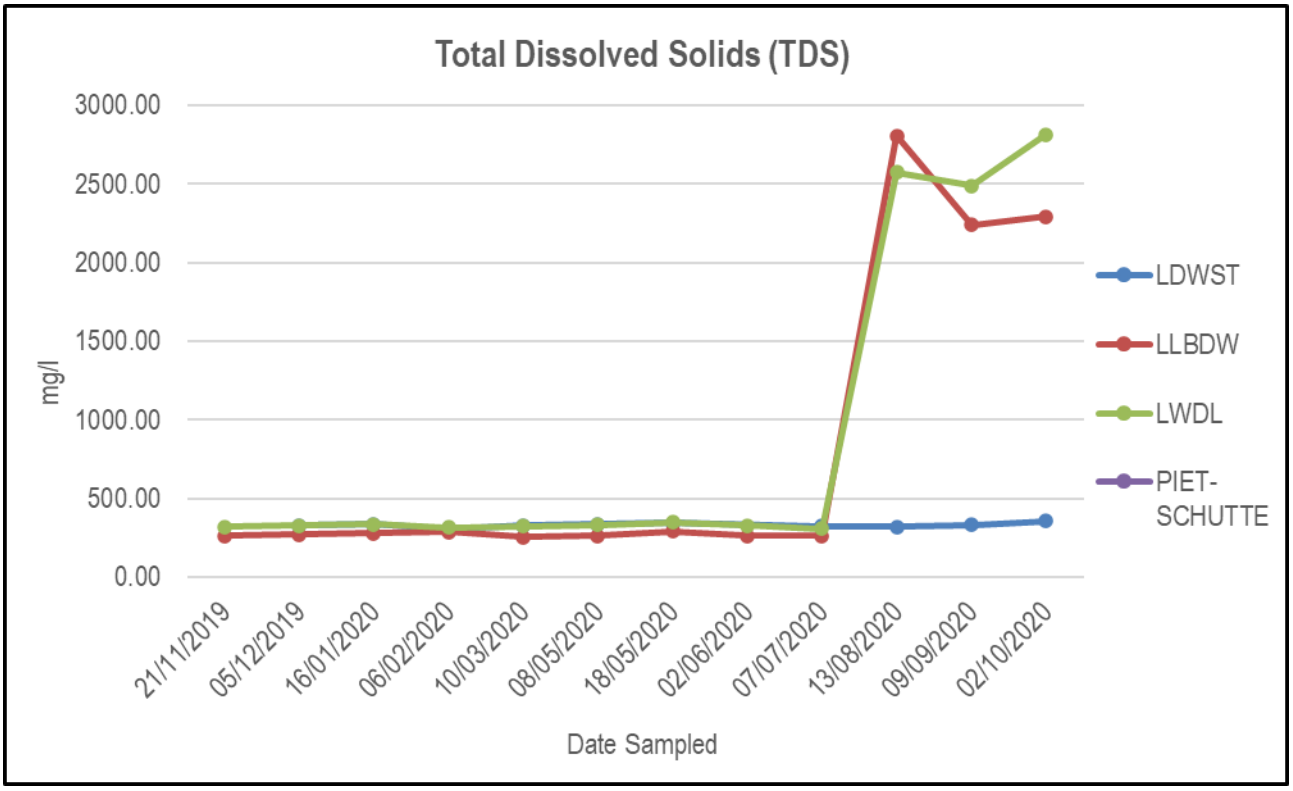


Figure 27: Total Dissolved Solids

Annexure D
Biannual Aquatic Biomonitoring Assessment



AQUATIC ASSESSMENT

BIANNUAL AQUATIC BIOMONITORING ASSESSMENT OF THE EXISTING EXXARO LEEUWPAN COLLIERY NEAR DELMAS MPUMALANGA, SOUTH AFRICA

DRY SEASON 2020

exxaro

POWERING POSSIBILITY



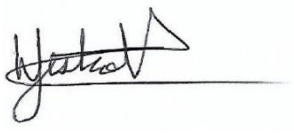
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ENVASS-EA

ENVIRONMENTAL ASSURANCE (Pty)Ltd

PREPARED FOR:	Exxaro Coal (Pty) Ltd.
PREPARED BY:	Environmental Assurance (Pty) Ltd.
SUBMITTED TO:	Lucy Mogakane
EMAIL:	Lucy.Mogakane@exxaro.com
DATE:	September 2020
PROPOSAL NUMBER:	BIM-REP-117-19_20
VERSION:	0.1

DOCUMENT CONTROL	
Document Title	Biannual Aquatic Biomonitoring Assessment of the Existing Exxaro Leeuwpan Colliery near Delmas Mpumalanga, South Africa: Dry Season 2020
Report Number	BIM-REP-117-19_20 (EXXARO- 2020 Dry)
Version	0.1
Date of Field Assessment	18 May 2020
Date of Report	July 2020
Date of Amendment	September 2020
Submitted to	Client: Exxaro Coal (Pty) Ltd. Contact Person: Lucy Mogakane Position: Environmental Officer Email: Lucy.Mogakane@exxaro.com
Distribution	x1 Exxaro Coal (Pty) Ltd. x1 Environmental Assurance (Pty) Ltd.
EXPERTISE OF AUTHOR	
Accreditations	Registered with South African Council for Natural Scientific Professionals (SACNASP) (no. 119357), DWS accredited SASS5 aquatic biomonitoring practitioner.

QUALITY CONTROL			
	Author	**Internal Review**	**Technical Review**
Name	Wietsche Roets	Wayne Westcott	Carl Schoeman
Designation	Environmental Scientist *Cand.Sci.Nat.*: 119357	Wetland and Aquatic Ecologist *Pr.Sci.Nat.*: 117334	Environmental Scientist *Pr.Sci.Nat.*: 114848
Signature			
Date	29-06-2020	14-07-2020	16-07-2020

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SPECIALIST DECLARATION:

I Wietsche Roets, declare that:

- I acted as an independent specialist;
- The assessment results were interpreted in an objective manner, even if the conclusions were not favourable to the client;
- I have the relevant expertise required to conduct a specialist report of this nature in terms of the National Environmental Management Act (NEMA) (Act no. 107 of 1998) and the National Environmental Management; Biodiversity Act (Act no. 10 of 2004);
- The contents of this report comply with the relevant legislative requirements, specifically Appendix 6 of the NEMA: EIA Regulations (2014, as amended in 2017);
- I understand that any false information published in this document is an offence in terms of Regulation 71 and is punishable in terms of Section 24(f) of the Act; and
- I am a registered scientist with the South African Council for Natural Scientific Professions (SACNASP).



Wietsche Roets

Cand.Sci.Nat. (no. 119357)

Suggested Report Citation:

Environmental Assurance, 2020. *Biannual Aquatic Biomonitoring Assessment of the Existing Exxaro Leeuwpan Colliery near Delmas Mpumalanga, South Africa: Dry Season 2020.* Prepared for Exxaro Coal (Pty) Ltd. July 2020.

EXECUTIVE SUMMARY

Environmental Assurance (Pty) Ltd. (ENVASS) was appointed by Exxaro Resources Limited (hereafter referred to as "Exxaro", or "the client") to conduct biannual aquatic biomonitoring assessments for both the wet and dry seasons within the 2020 annual period. As per the Water Use License (WUL) (Ref no.: 04/B20A/CIJ/4032) that was granted to Exxaro Coal (Pty) Ltd. (hereafter referred to as "Exxaro", or "the client") for the water uses associated with the Leeuwpan Colliery on the 18th December 2015 in terms of Chapter 4 of the National Water Act (Act no. 36 of 1998) for Section 21(c), (i) and (g), biannual biomonitoring must be conducted on all potentially impactable aquatic ecosystems. This report was drafted for the predetermined biomonitoring sampling points associated with the Leeuwpan Colliery and fulfils the requirement for a dry season assessment to be conducted of all the biomonitoring reaches identified in the vicinity of the colliery for the year of 2020. The Leeuwpan Colliery and the associated biomonitoring sites will hereafter be referred to as the study area within this report.

The field survey relevant to this aquatic impact assessment report was conducted on the 18th May 2020 within the South African National Biodiversity Institute (SANBI) prescribed dry season for the region (**Figure ES1**). This report should be read in conjunction with the ENVASS (2020) MON-WQR-080-19_20 (20-05) monthly water quality monitoring report.

Monitoring Sites:

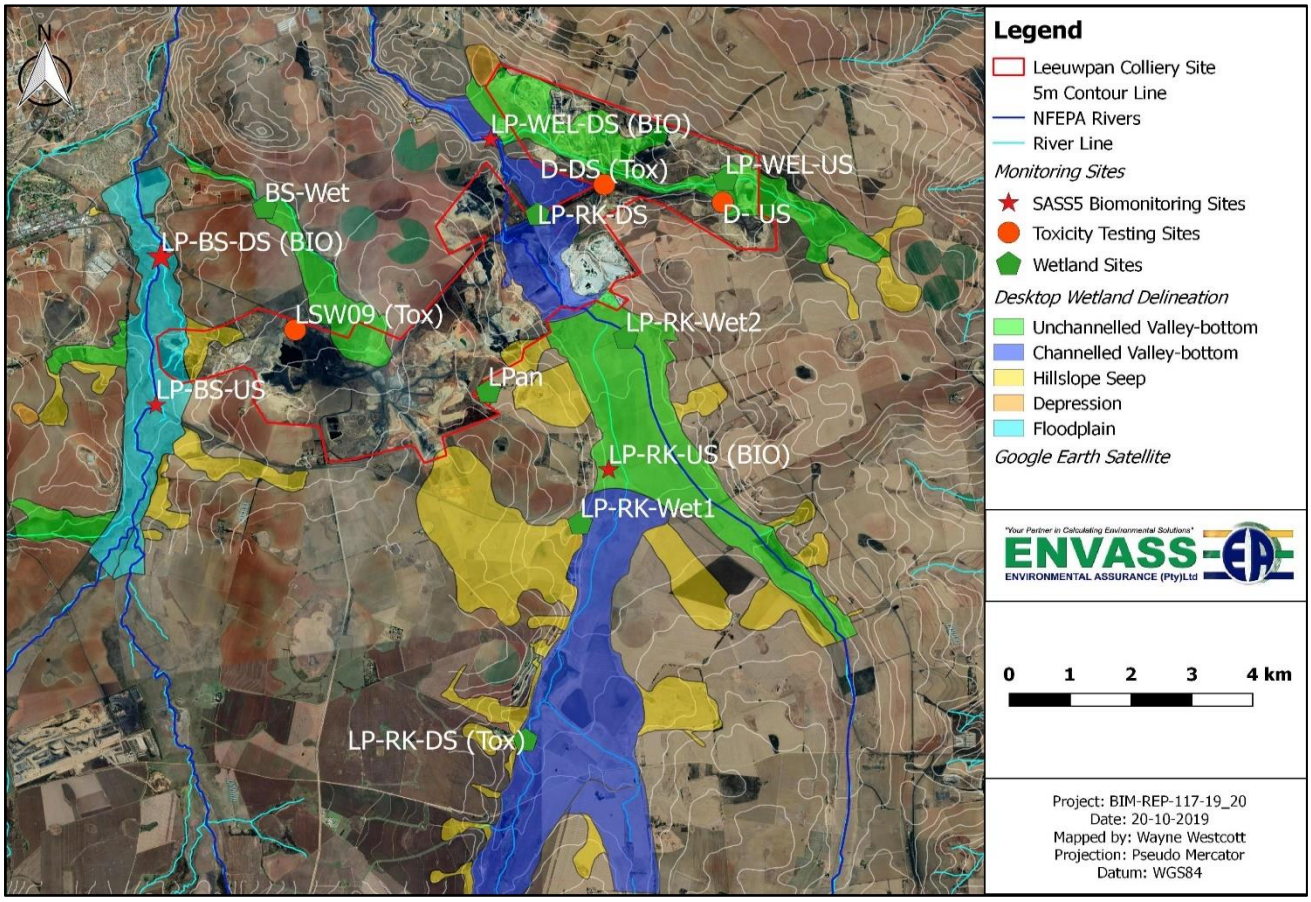


Figure ES1: All monitoring sites relevant to the Leeuwpan Colliery.

Water Quality:

In situ water quality was recorded at the in-flow biomonitoring sites associated with the Leeuwpan Colliery using a handheld Aquaprobe 800 meter during the field survey. The results of the 2020 dry season field survey presented exceedances of the Target Water Quality Ranges (TWQRs) for Total Dissolved Solids (TDS) and Dissolved Oxygen (DO) (%) at both the downstream LP-BS-DS and LP-WEL-DS sites, with only TDS exceeding the TWQR at both the upstream LP-BS-US and LP-RK-US sites.

Table ES1: Summary table presenting the water quality data obtained at the Leeuwpan Colliery biomonitoring sites during the 2019 and 2020 dry season field survey (Red indicated readings that were outside of relevant TWQR).

SAMPLE POINT	DRY SEASON	pH	CONDUCTIVITY mS/m	TDS (Mg/l)	DO (Mg/l)	DO (%)	TEMP. (ºC)
TWQR	YEAR	6.5-9.0	<70	<100 mg/l	>5.00	80-120	5-30
LP-BS-US (upstream)	2020	8.19	61.10	397.00	9.16	112.3	16.85
	2019	DRY/NO FLOW					
LP-BS-DS (downstream)	2020	8.39	62.90	408.00	6.26	71.60	13.90
	2019	9.46	45.40	295.00	6.41	75.40	14.90
LP-RK-US (upstream)	2020	7.54	47.00	305.00	7.45	92.80	17.73
	2019	DRY/NO FLOW					
LP-WEL-DS (downstream)	2020	7.10	53.80	349.00	6.31	70.20	12.65
	2019	9.88	45.50	297.00	4.17	49.30	14.93

Toxicity and Diatom Testing

The toxicity testing at the Bronkhorstspruit River downstream (LP-BS-DS) site concluded that the water column can be considered as containing a slight environmental toxicity hazard, represented by a score falling within Class II. These results were mirrored by the diatom analysis, which concluded that the water was determined to have been moderately polluted by organic constituents and the upstream point did however reveal no toxicity hazard, with diatom analysis revealing lower organic pollution levels. The Weltevreden Tributary downstream (LP-WEL-DS) site was concluded to be eutrophic in nature, whereas the upstream divergent channel 3 (D-DS) associated with the site activities indicated no toxicity hazard. Overall, the conclusion was that the biomonitoring sites had been impacted on as diatom analysis revealed poor water quality in terms thereof. However, it cannot be conclusively stated that the source of the toxicity recorded is attributed to the site activities undertaken by Exxaro.

Integrated Habitat Assessment System (IHAS):

The Integrated Habitat Assessment System (IHAS) model analysis of the assessed reaches at the Leeuwpan Colliery biomonitoring points calculated results that were categorised as inadequate (**Table ES2**). The habitat at all sites was not deemed adequate to support a diverse aquatic macroinvertebrate community.

The South Afirican Scoring System Ver. 5 (SASS5) scores were interpreted using the IHAS results as well as the results obtained after conducting the visual and water quality assessments.

Table ES2: Summary table of the Integrated Habitat Assessment System (IHAS) scores for the Leeuwpan Colliery biomonitoring sites during the 2019 and 2020 field survey.

BIOMONITORING POINT	DRY SEASON	IHAS SCORE	CATEGORY	CHARACTERISTICS
LP-BS-US (Upstream)	**2020**	57 %	**Inadequate:** Habitat insufficient for supporting a diverse macroinvertebrate community.	• Dominating habitat was GSM which consisted predominantly of mud. • Few stones, with 60 % covered in Algae. • Water was damming downstream before the bridge with low flow upstream and downstream thereof. • Vegetation was moderately divers with an abundance of grass on the stream bed.
	2019	**DRY/NO FLOW**		
LP-BS-DS (Downstream)	**2020**	48 %	**Inadequate:** Habitat insufficient for supporting a diverse macroinvertebrate community.	• Little to no Stone (S) biotope was available for sampling. A stretch of approximately 1 m was sampled. • Deep pools in two areas upstream and downstream of

BIOMONITORING POINT	DRY SEASON	IHAS SCORE	CATEGORY	CHARACTERISTICS
	2019	44 %	**Inadequate:** Habitat insufficient for supporting a diverse macroinvertebrate community.	a bridge structure were sampleable. • Riparian vegetation was absent, however fringe vegetation included sedges and grass species. • Reach was dominated by GSM, with sand being the most prominent aspect.
LP-RK-US (Upstream)	**2020**	**STAGNANT POOL/NO FLOW**		
	2019	**DRY/NO FLOW**		
LP-WEL-DS (Downstream)	**2020**	59	**Inadequate:** Habitat insufficient for supporting a diverse macroinvertebrate community.	• A single run of approximately 4 m comprised of stones of between 2 and 10 cm was sampled. • A deep pool with a sand/gravel substrate with intermittent stones was sampled. • Algae was present on most stones and on the surface of the water. • Vegetation was limited to sedges and reeds with grass species not interacting with the water body.
	2019	52 %	**Inadequate:** Habitat insufficient for supporting a diverse macroinvertebrate community.	

Aquatic Biomonitoring

Out of the four (4) predetermined biomonitoring sites, only three (3) were sampleable and the results were analysed during the 2020 dry season field survey (**Table ES03**). During the field survey, between 17 and 22 taxa were identified at the different sites associated within the assessed reaches. There were no River Health Programme (RHP) reference sites situated in the B20A quaternary catchment area, and thus the SASS5 interpretation guidelines constituted as the only 'natural' sites to compare the overall results against.

The following observations were made when comparing the 2020 dry season data to the information that was recorded from the previous 2019 dry season survey:

- **LP-BS-US**: No change could be determined between 2019 and 2020, as this site was dry in 2019. However, when compared to the 2018 result the SASS Score and number of taxa were recorded to be 18 % and 29 % higher (better) in 2020 than in 2018, respectively. This resulted in the ecological category improving from a Class D (Near natural) to a Class C (Moderately modified) in 2020.
- **LP-BS-DS**: When comparing the 2020 results to those obtained in 2019, the SASS Score and number of taxa were recorded to be 46 % and 45 % higher (better) in 2020 than in 2019, respectively. This resulted in the ecological category improving from a Class E/F (Seriously Modified) to a Class B (Near natural) in 2020.
- **LP-RK-US**: No change could be determined as this site was dry in 2019 and only a small stagnant pool was noted in 2020, and thus it was also not sampled.
- **LP-WEL-DS**: The SASS Score and number of taxa were recorded to be 15 % and 16 % higher (better) in 2020 than in 2019, respectively. This resulted in the ecological category improving from a Class C (Moderately modified) to Class B (Near natural) in 2020.

The following will compare the upstream scoring to those obtained at the corresponding downstream sites:

- LP-BS-US to LP-BS-DS: The ASPT at the upstream point (LP-BS-US) was 13 % lower (worse) than in 2018 (dry in 2019), however the Ecological category improved unto a class C due to the increase of taxa that is likely due to a reduction of pollution and increased flow recorded at this point. This was furthermore reflected by the improvement recorded at the downstream point (LP-DS-DS) that recorded a major improvement in ecological category (from E/F unto B) and slight improvement in ASPT. This overall improvement is likely due to increased input of water into the system prior to sampling resulting in the improved conditions and habitat availability.
- LP-RK-US to LP-WEL-DS: The upstream tributary point (LP-RK-US) indicated stagnant conditions and could not be assessed using SASS5 methodologies. However, the improvement unto a class B ecological state was noted at the downstream (LP-WEL-DS) point. Since the SASS score and number of Taxa was higher in comparison to the previous monitoring period and the ASPT remained the same, it can be concluded that the increased flow resulted in higher habitat availability for tolerable species but the absence of sensitive species reveals that water quality remains impacted.

In comparison these findings reveal that an increase in pollution tolerant species were present, likely due to the reduction in water quality and increased quantity during the assessment period when comparing results from the upstream to downstream environments. This statement is made due to the increased amounts of taxa and decreased or similar ASPT values as described above.

Table ES03: SASS5 results collected and analysed for the sites associated with the Leeuwpan Colliery.

SAMPLE POINT	SEASON	NO. OF TAXA	% CHANGE SINCE LAST PERIOD	SASS5 SCORE	% CHANGE SINCE LAST PERIOD	ASPT	% CHANGE SINCE LAST PERIOD	ECOLOGICAL CATEGORY
LEEUWPAN COLLIERY								
LP-BS-US (Upstream)	**DRY 2020**	**17**	**29↑**	**66**	**18↑**	**3.9**	**13↓**	**C**
	DRY 2019	**DRY/NO FLOW**						
	DRY 2018	12	**N/A**	54	**N/A**	4.5	**N/A**	**D**
LP-BS-DS (Downstream)	**DRY 2020**	**22**	**45 ↑**	**85**	**46 ↑**	**3.9**	**3 ↑**	**B**
	DRY 2019	12		46		3.8		**E/F**
	DRY 2018	12		46		3.8		**E/F**
LP-RK-US (Upstream)	**DRY 2020**	**STAGNANT**						
	DRY 2019	**DRY/NO FLOW**						
	DRY 2018	15	**N/A**	60	**N/A**	4.00	**N/A**	**D**
LP-WEL-DS (Downstream)	**DRY 2020**	**19**	**16 % ↑**	**87**	**15 % ↑**	**4.6**	**0 %**	**B**
	DRY 2019	16		74		4.6		**C**
	DRY 2018	20		100		5.0		**B**

KEY: ↑ - Increased since last monitoring period, ↓ - Decrease since last monitoring period.

Conclusion

It is evident that the aquatic systems in the vicinity of the existing licensed Leeuwpan Colliery have been moderately disturbed and thus degraded by the current and historical land-uses, specifically agriculture, within the catchment area. Based on the toxicity testing and diatom assessment that were conducted for the 2020 dry season survey, it is the specialists substantive opinion that the Leeuwpan Colliery was having having a slight negative impact on the downstream aquatic ecosystems at LP-BS-DS and LP-WEL-DS. However, based on the water quality, IHAS and SASS5 analysis this impact can be mitigated by following protocol throughout the production process onsite, adhering to the limits stipulated within the WUL (Ref no. 04/B20A/CIJ/4032) and implementing the recommendation stipulated below. The attributes that influenced this conclusion included the following:

- Slight decrease in overall water quality from upstream sites LP-BS-US to LP-BS-DS and from LP-RK-US to LP-WEL-DS. This trend was mirrored in the diatom assessment, which highlighted more eutrophic and higher pollution levels at the LP-BS-DS site than the upstream LP-BS-US site. Adversely, more organic pollution was recorded at the upstream LP-RK-US site than at the corresponding downstream LP-WEL-DS site, but both samples indicated eutrophic conditions.
- The upstream site (LP-BS-US) was determined to pose no acute or short-chronic environmental hazard, however the downstream site (LP-BS-DS) was determined to be of a slight environmental toxicity hazard presented by a Direct Estimate of Ecological Effect Potential (DEEEP) Class II. Subsurface seepage from a historic farm dam situated within the Leeuwpan Colliery at 26° 10’ 00.22” S, 28° 42’ 41.98” E was observed to be flowing into the downstream tributary of the Bronkhorstspuit River above site LP-BS-DS. There may therefore be an influence from this farm dam on the change in toxicity levels evident at LP-BS-DS. Surrounding land-uses were also considered, however as a higher flow volume was entering the system from farm dam than the agricultural croplands and stormwater runoff from the adjacent tar road, it was determined to have a higher influence on this conclusion.
- The previously elevated pH has decreased unto overall acceptable levels, likely the result of dilution due to increased rainfall in the area prior to the assessment. This was mirrored by both sites having improved and only LP-WEL-DS being determined to fall within Class II (Slight environmental toxicity hazard) toxicity, LP-WEL-DS recording Some Degree of Acute/Short- chronic Toxic Hazard (S.D.O.T.H) at one (1) trophic level.
- The diatom analysis recorded eutrophic conditions at LP-WEL-DS and the conclusion was that the habitat decreased and impacted water quality was evident. The diatom analysis on the downstream point LP-BS-DS also indicated slightly impacted water quality, however this impact was largely present in the upstream environment at LP-BS-US as well. However, since the on-site sampled revealed no acute toxicity it cannot be conclusively stated that the pollution is attributed to the site. These results revealed that surrounding activities in the upstream environment had a definitive impact and only a slight decrease was observed at the downstream point.
- The overall increase in aquatic macroinvertebrate health at the downstream biomonitoring sites was presumably due to the dilution of water attributed to the elevated availability of water at the monitoring points and the overall increased water quality measured and therewith the slightly improved habitat.

Specialist's Recommendation

- The slopes of the artificial earthen channels that have been excavated to divert flow around the mining areas should be landscaped to slopes exhibiting a ratio of 1:3 (v:h) and revegetation with plugs from the surrounding wetland area. This will provide further filtration of the stormwater runoff and episodic flow through the channels and into the downstream Weltevredenspruit tributary. Ideally, the existing wetlands on-site should be maintained at their base-line Present Ecological State score (PRES) by implementing rehabilitation and mitigation measures. This will increase the filtration of potentially harmful contaminants that may be present in the surface- and subsurface-flow that may be originating from the Leeuwpan Colliery.
- Toxicity testing of the water within the historic farm dam at 26° 10' 00.22" S, 28° 42' 41.98" E should be considered. This may further narrow the search for any potential contamination sources on-site and create further measures of monitoring the potential impact on water quality within the downstream aquatic ecosystems.
- Clearing of Invasive Alien Plant Species (IAPS) from the aquatic ecosystems in areas under the control of the mine and associated with the reaches on which the affected biomonitoring points are situated to improve the water balance and natural biodiversity within and around the system. The controlling and maintenance of all IAPS on a landowner portion is a legal requirement in terms of the National Environmental Management: Biodiversity Act (Act no. 10 of 2004) Alien and Invasive Species List, 2016 (DEA, 2016).
- Ongoing monitoring of the aquatic community integrity, that is implemented at the Leeuwpan Colliery, should be maintained.
- The results presented within this biannual 2020 dry season aquatic assessment of the biomonitoring points associated with the Leeuwpan Colliery must be spatially and temporally compared to the results obtained during previous and future dry season biomonitoring studies. If the comparison highlights any significant alteration in the health/integrity of the at-risk or downstream aquatic ecosystems, the cause, extent and significance of the impact must be identified and appropriate mitigation and/or rehabilitation measures implemented to improve the health of the impacted systems.

TABLE OF CONTENTS

1 INTRODUCTION 1
1.1 Background 1
1.2 Locality 1
1.3 Applicable Legislation 3
2 ASSUMPTIONS AND LIMITATIONS 5
3 OBJECTIVES 5
4 SCOPE OF WORK 6
5 METHODOLOGY 6
5.1 Aquatic Assessment 6
5.2 Desktop Assessment 7
5.3 Visual Inspection 8
5.4 Physicochemical Water Quality Analyses 9
5.5 Index of Habitat Integrity Assessment (IHIA) 9
5.6 Integrated Habitat Assessment System (IHAS) 11
5.7 South African Scoring System Ver. 5 (SASS5) 11
6 DESKTOP ASSESSMENT 13
6.1 Hydrological Setting 13
6.2 Ecoregion 15
6.3 Sub-Quaternary Reaches (SQRs) 17
6.4 Land Use 20
6.5 Vegetation 20
6.6 Conservation Plan: Mpumalanga Province 24
6.7 National Freshwater Ecosystem Priority Areas (NFEPAs) 24
6.8 Geology and Soils 27
7 BIOMONITORING SAMPLE SITES 30
7.1 Description of the Biomonitoring Points 32
8 RESULTS XXXVII
8.1 Physicochemical Water Quality xxxvii
8.2 Toxicity Testing xxxix
8.3 Diatom Analysis xliii
8.3.1 Ecological Classification xliii
8.3.2 Diatom Spatial Analysis xliv
8.4 Integrated Habitat Assessment System (IHAS) xlvi
8.5 South African Scoring System 5 (SASS5) Data Interpretation xlviii
9 CONCLUSION AND SPECIALIST'S RECOMMENDATION LI

10 REFERENCES 54
11 APPENDIX A: SPECIALIST'S QUALIFICATIONS 57

LIST OF TABLES

Table 1: Description of the legislation that was considered when drafting this aquatic biomonitoring assessment. 3
Table 2: Presentation of the datasets and available information that was utilised during the desktop study associated with this assessment. 7
Table 3: Category of score for the Present Ecological State (PES). 10
Table 4: Classification of the Present Ecological State (PES) Classes in terms of Habitat Integrity (Based on Kemper, 1999). 10
Table 5: Presentation of the classes used to interpret the IHAS results. 11
Table 6: Classification protocol for determining the Present State Class as modelled for the Highveld- Lower ecoregion (Dallas, 2007). 13
Table 7: Main attributes associated with the Highveld Ecoregion. 15
Table 8: Characteristics of the Sub-Quaternary Reaches (SQRs) associated with the biomonitoring points. 17
Table 9: Fish species that could occur within the two SQRs associated with the study area (DWS, 2014; IUCN, 2020; Skelton, 2001). 18
Table 10: Site characteristics recorded within the assessed reach at the LP-WEL-DS site. 32
Table 11: Site characteristics recorded within the assessed reach of upstream LP-RK-US. 33
Table 12: Site characteristics recorded within the assessed reach at site LP-BS-US. 34
Table 13: Site characteristics recorded within the assessed reach at LP-BS-DS. 35
Table 14: *In situ* water quality of the samples collected during the 2019 and 2020 dry season field survey (Red indicates those readings outside of the relevant TWQR). xxxvii
Table 15: Presentation of the overall hazard classed based on the DEEEP protocol. xxxix
Table 16: Acute Toxicity Analysis of the water samples that were collected at the relevant biomonitoring sites. xl
Table 17: Acute Toxicity Analysis of the additional water samples that were collected at the relevant sites. xlii
Table 18: Ecological descriptions of the four (4) sites at the Leeuwpan Colliery based on the diatom community (van Dam *et al*., 1994; Taylor *et al*., 2007). xliii
Table 19: Diatom index scores for the study sites that had sufficient diatom counts to determine the ecological condition of the water column. xlvi
Table 20: The Integrated Habitat Assessment System (IHAS) scores for the Leeuwpan Colliery biomonitoring sites during the 2019 and 2020 field survey. xlvii
Table 21: SASS5 results collected and analysed for the sites associated with the Leeuwpan Colliery. xlix

LIST OF FIGURES

Figure 1: Locality map of the study area in relation to surrounding towns and municipal boundaries within the Gauteng Province, South Africa. 2
Figure 2: Illustration of the quaternary catchment area and Water management Areas (WMAs) that were associated with the study area (DWS, 2012). 14
Figure 3: Ecoregion associated with the study area (DWS, 2012). 16
Figure 4: Illustration of the SQRs that are relevant to the biomonitoring sites within the study area. 19
Figure 5: Land cover associated with the proposed development study area (SANBI, 2013/14). 21
Figure 6: Terrestrial vegetation types associated with the proposed development study area (SANBI, 2006-2018). 22
Figure 7: Illustration of the wetland vegetation types and their conservation status relevant to the study area. 23
Figure 8: Terrestrial Conservation Units that were determined to be relevant to the study area (MBCP, 2006). 25
Figure 9: Illustration of the NFEPA wetland and river systems that were recorded within and around the study area (Driver *et al*., 2011). 26
Figure 10: Illustration of the lithostratigraphic units that were recorded within the study area (Council of Geoscience, 2008). 28
Figure 11: Illustration of the hydrological runoff potential of the soil forms within the study area. 29
Figure 12: All monitoring sites relevant to the Leeuwpan Colliery. Only the biomonitoring sites were relevant to this dry season study. 31
Figure 13: Illustration of the SASS interpretation guideline relevant to the Highveld- Lower ecoregion (Dallas, 2007). li

LIST OF ABBREVIATIONS AND ACRONYMS

TERM	EXPANSION
ASPT	Average Species Per Taxa
BA	Biodiversity Area
CBA	Critical Biodiversity Area
CR	Critically Endangered
DAFF	Department of Agriculture, Forestry and Fisheries
DWA	Department of Water Affairs
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
EMPr	Environmental Management Programme
EN	Endangered
ESS	Ecosystem Services
FEPA	Freshwater Ecosystem Priority Area
FHIA	Freshwater Habitat Impact Assessment
GG	Government Gazette
GIS	Geographic Information System
GN	General Notice
GPS	Geographic Positioning System
HGM	Hydrogeomorphic
IAPS	Invasive Alien Plant Species
IHI	Index of Habitat Integrity
LT	Least Threatened
MAMSL	Meters Above Mean Sea Level
MAP	Mean Annual Precipitation
MASR	Mean Annual Surface Runoff
MAT	Mean Annual Temperature
NEMA	National Environmental Management Act (Act no. 107 of 1998)
NFEPA	National Freshwater Ecosystem Priority Area

TERM	EXPANSION
NWA	National Water Act (Act no. 36 of 1998)
PES	Present Ecological State
PU	Planning Unit
REC	Recommended Ecological Category
RMO	Recommended Management Objective
RWQO	Resource Water Quality Objectives
SANBI	South African National Biodiversity Institute
SASS5	South African Scoring System Version 5
SCC	Species of Conservation Concern
TWQR	Target Water Quality Range
VU	Vulnerable
WMA	Water Management Area
WULA	Water Use Licence Application
WUL	Water Use Licence

1 INTRODUCTION

1.1 Background

Environmental Assurance (Pty) Ltd. (ENVASS) was appointed by Exxaro Resources Limited (hereafter referred to as "Exxaro", or "the client") to conduct biannual aquatic biomonitoring assessments for both the wet and dry seasons within the annual period. As per the Water Use License (WUL) (Ref no.: 04/B20A/CIJ/4032) that was granted to Exxaro Coal (Pty) Ltd. (hereafter referred to as "Exxaro", or "the client") for the water uses associated with the Leeuwpan Colliery on the 18th December 2015 in terms of Chapter 4 of the National Water Act (Act no. 36 of 1998) for Section 21(c), (i) and (g), biannual biomonitoring must be conducted on all potentially impactable aquatic ecosystems. This report was drafted for the predetermined biomonitoring sampling points associated with the Leeuwpan Colliery and fulfils the requirement for a dry season assessment to be conducted of all the biomonitoring reaches identified in the vicinity of the colliery for the year of 2020. The Leeuwpan Colliery and the associated biomonitoring sites will hereafter be referred to as the study area within this report.

The field survey relevant to this aquatic impact assessment report was conducted on the 18th May 2020 within the South African National Biodiversity Institute (SANBI) prescribed dry season for the region. This report should be read in conjunction with the ENVASS (2020) MON-WQR-080-19_20 (20-05) monthly water quality monitoring report.

1.2 Locality

The Leeuwpan Colliery is located approximately 5 Kilometres (km) north of the town of Delmas, which is situated in the Victor Khanye Local and Nkangala District Municipalities within the Mpumalanga Province of South Africa. **Figure 1** overleaf presents the Leeuwpan Colliery in relation to the surrounding towns within the relevant municipal boundaries.

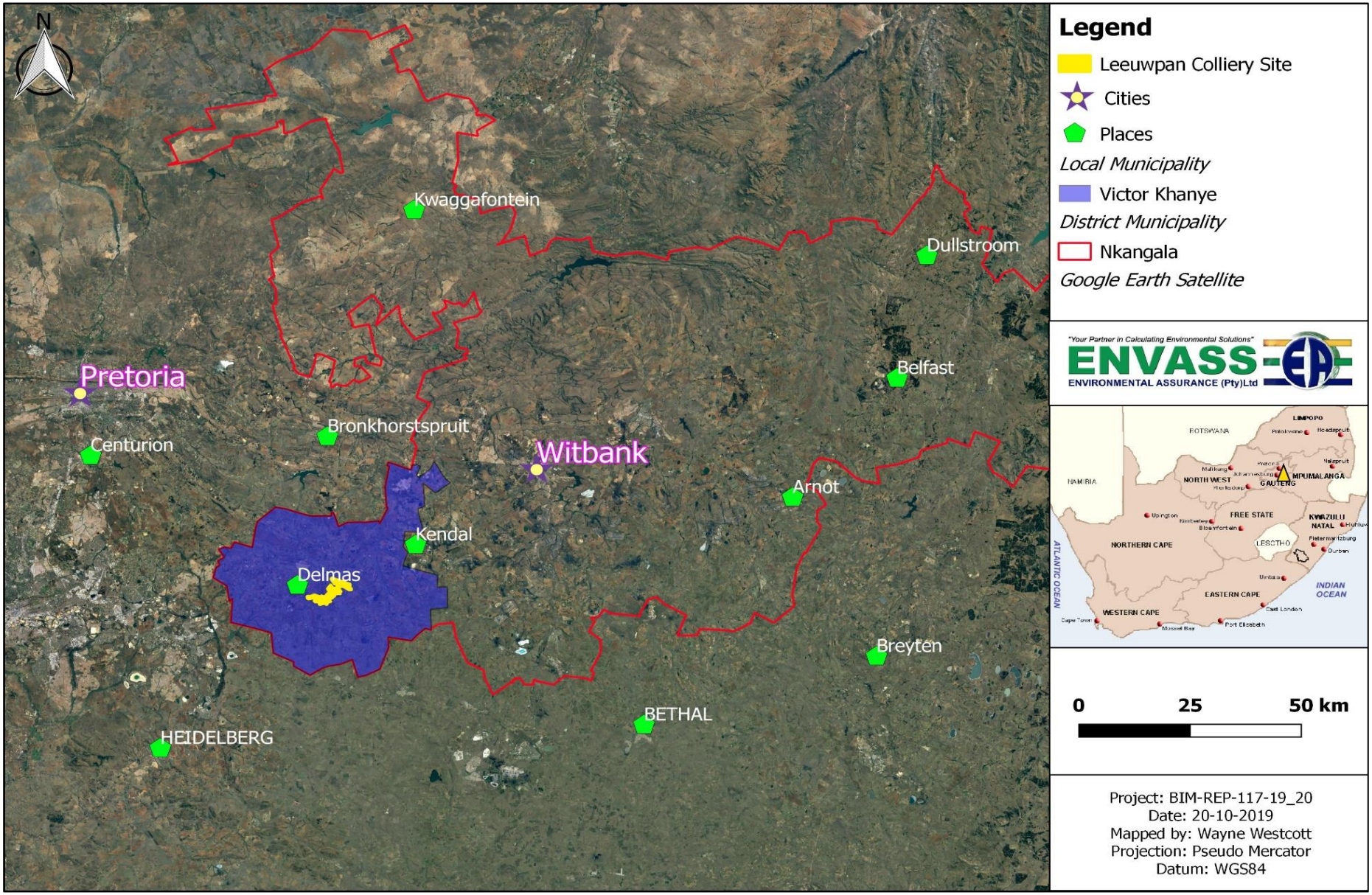


Figure 1: Locality map of the study area in relation to surrounding towns and municipal boundaries within the Gauteng Province, South Africa.

1.3 Applicable Legislation

This study was conducted and the relevant data and/or information obtained in accordance, or with consideration to, the following legislation (**Table 1**).

Table 1: Description of the legislation that was considered when drafting this aquatic biomonitoring assessment.

LEGISLATION	DESCRIPTION
South African Constitution (Act no. 108 of 1996)	The constitution is the overarching framework of South African law. It provides a legal foundation for the existence of the republic, outlines the rights and responsibilities of South African citizens and it defines the structure of government. Chapter 2- Bill of rights (Section 24) Everyone has a right to an environment that is not harmful to their health or wellbeing and is protected through reasonable legislative or other measures. (Section 27) National government is the custodian of all the country's water resources.
Conservation of Agricultural Resource Act (CARA) No. 43 of 1983	This act deals with control of the over-utilization of South Africa's natural agricultural resources, and to promote the conservation of soil and water resources and natural vegetation. This includes wetland systems and requires authorizations to be obtained for a range of impacts associated with cultivation of wetland areas.
DWS General Notice 509 Government Gazette no. 40229 (2016)	This GA replaces the need for a water user to apply for a license in terms of the NWA provided that the water use is within the ambit of the aforementioned GA. Although this GA is legislated throughout South Africa, it only applies to water use in terms of Section 21 (c) and (i) of the NWA within the regulated area of a watercourse. In order to understand and interpret GN 509 (2016) the following definitions must be presented and expanded upon (GN509, 2016): Characteristics of a watercourse: the resource quality of a watercourse within the extent of a watercourse; Diverting: To, in any manner, cause the instream flow of water to be rerouted temporarily or permanently; Extent of a watercourse: (a) The outer boundary of the 1:100year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse; and (b) Wetlands and pans: the delineated boundary (outer temporary zone) of any wetland or pan. Flow-altering: To, in any manner, alter the instream flow route, speed or quantity of water temporarily or permanently. Impeding: to, in any manner, hinder or obstruct the instream flow of water temporarily, or permanently, but excludes the damming of flow so as to cause storage of water. Regulated area of a watercourse: For Section 21 (c) and (i) of the NWA water uses in terms of GN509 means:

LEGISLATION	DESCRIPTION
	(a) The outer boundary of the 1:100year flood line and/or delineated riparian habitat, whichever is the greatest distance, measured from the middle of the watercourse; (b) In the absence of a determined 1:100year flood line or riparian area the area within 100m from the edge of a watercourse where the edge of the watercourse if the first identifiable annual bank fill flood bench; or (c) A 500m radius from the delineated boundary of any wetland or pan. Rehabilitation: The process of reinstating natural ecological driving forces within part or the whole of a degraded watercourse to recover former or desired ecosystem structure, function, biotic composition and associated Ecosystem Services (ESS). Watercourse: (a) a river or spring; (b) a natural channel in which water flows regularly or intermittently; (c) a wetland, lake or dam into which, or from which, water flows; and (d) any collection of water which the Minister may, by notice in the Gazette declare to be a watercourse. Wetland: 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.
National Environmental Management Act (NEMA): EIA Regulations (2014, as amended in 2017)	As the primary purpose of this assessment is to provide specialist input into the environmental management process, including the water use license application, associated with the proposed development the author has drafted this specialist report in accordance with the requirements listed under Appendix 6 of the NEMA: EIA Regulations (2014, as amended).
National Water Act (NWA) (Act no. 36 of 1998)	The purpose of the NWA is to ensure that the national water resources are protected, used, developed, conserved, managed and controlled in ways which take into account amongst other factors: (g) protecting aquatic and associated ecosystems and their biological diversity: (h) reducing and preventing pollution and degradation of water resources; In terms of the NWA, water use is broadly defined as, and includes taking and storing water, activities which reduce stream flow, waste discharges and disposals, controlled activities (activities which impact detrimentally on a water resource), altering a watercourse, removing water found underground for certain purposes, and recreation. In general, a water use must be licensed unless it is listed in Schedule I, is an existing lawful use, is permissible under a General Authorisation (GA), or if a responsible authority waives the need for a license. The water uses, as listed under Section 21 of the NWA, that are applicable to this project are: (c) impeding and diverting the flow of water in a watercourse; and (i) altering the bed, banks, course or characteristics of a watercourse.

LEGISLATION	DESCRIPTION
National Environmental Management Act: Biodiversity Act (NEM:BA) (Act No. 10 of 2004)	The objectives of the NEM:BA are (within the framework of NEMA) to provide for: (i) the management and conservation of biological diversity within the Republic and of the components of such biological diversity; (ii) the use of indigenous biological resources in a sustainable manner; and (iii) the fair and equitable sharing among stakeholders of benefits arising from bioprospecting involving indigenous biological resources.
Victor Khanye Local Municipality bylaws	These legislated documents must be reviewed by the design team to ensure that all requirements regarding conservation targets and land-use zonation/planning is met and the proposed development is in-line with the overall purpose of the area. All construction activities must also adhere to the requirements stipulated within these bylaws.

2 ASSUMPTIONS AND LIMITATIONS

The following assumptions and limitations are relevant to this aquatic study:

- A dry season aquatic study was to be conducted within the SANBI prescribed dry season for the annual period. Only biomonitoring sites that were recorded to be sampleable (i.e. had sufficient flow) in accordance with the ISO certified South African Scoring System ver. 5 (SASS5) methodology must be assessed.
- The primary objective of this study was to assess the impact of the existing Licensed Exxaro Leeuwpan Colliery on the receiving aquatic environment from an aquatic macroinvertebrate perspective.
- This study did not include water quality analyses through a SANAS accredited laboratory, and thus a handheld Aqua probe AP-800, which was calibrated prior to use, was utilised to measure the *in situ* water quality at each biomonitoring site.
- The assessment of impacts and recommendation of mitigation measures was informed by the site-specific ecological issues identified during the field survey and based on the assessor's working knowledge and experience with similar mining activity projects.
- This report will be submitted to the Department of Water and Sanitation (DWS) case officer for review and record purposes.

3 OBJECTIVES

The primary objective of this aquatic biomonitoring assessment was to gather results from the potentially at-risk aquatic systems in the vicinity of the Leeuwpan Colliery to ascertain whether the production and associated activities have had an impact on the Present Ecological State (PES) of the systems. The quantitative data that was gathered by implementing best-practice and legislated methodologies and techniques was compared to the baseline condition of the various biomonitoring points to determine the long-term PES (integrity) trends of the aquatic ecosystems.

Based on the identified trends and the potential impacts recorded (if any), mitigation and/or rehabilitation measures were recommended and must be implemented to maintain the Recommended Management Objectives (RMOs) that have been set for each system by the Department of Water and Sanitation (DWS) River Eco-status Monitoring Programme (REMP) (previously the River Health Programme (RHP)).

4 SCOPE OF WORK

ENVASS was appointed to conduct biomonitoring, toxicity testing, fish surveys, diatom analysis and wetland assessment at sites in and around the existing Leeuwpan Colliery during the wet and dry season assessment periods. Due to the non-perennial nature of the watercourses on and around the site, the Scope of Work (SoW) different between seasons. The following will present the SoW relevant to the dry season period:

1. Detailed desktop study, mapping and literature review of all data and studies relevant to the study area;
2. Aquatic biomonitoring of four (4) sites using the South African Scoring System ver. 5 (SASS5) methodology;
3. Aquatic habitat assessment of the aforementioned biomonitoring sites using the Integrated Habitat Assessment System (IHAS) methodology;
4. *In situ* water quality testing of the pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS) & Dissolved Oxygen (DO) at the biomonitoring sites;
5. Toxicity testing of three (3) sites in and around the study area using the Direct Estimation of Ecological Effect Potential (DEEP) protocol;
6. Diatom analysis on samples collected from the four (4) biomonitoring sites in around the study area; and
7. Compile a single report for the 2020 dry season period.

5 METHODOLOGY

The following section will outline the various methodologies and tools that were utilised during this study, which was associated with the Leeuwpan Colliery.

5.1 Aquatic Assessment

Assessment of the freshwater ecosystem entail the characterisation of the aquatic environment, aquatic habitat and associated biota. In order to enable an adequate description of the aquatic environment and determination of the PES, the following stressor, habitat and response indicators will be evaluated:

- Current and potential threats to water quality and watercourse condition;
- Information regarding upstream and downstream conditions, point and non-point pollution sources, water usage etc. and translate it into information that may be used to measure the compliance against WUL conditions and the integrity of the watercourses;
- Baseline data with regard to PES, resources water quality objectives and the desired future system condition;

- Isolate point source impacts and assess the nature and significance of these impacts;
- Implement the most up-to-date best practice methodologies and techniques (e.g. South African Scoring System Version 5 (SASS5) (Dickens & Graham, 2002)) to accurately assess the current and change in condition within each reach;
- Expand on the baseline condition at each watercourse against which future studies and monitoring works may be measured;
- Provide specialist recommendations that may be implemented to mitigation and/or rehabilitated the identified and quantified impacts; and
- Develop a comprehensive report containing result analyses and specialist recommendations that will assist with decisions and the development of management objectives.

5.2 Desktop Assessment

A desktop assessment was undertaken, in which all the available data (e.g. government records and previous studies) pertaining to the study area was sourced and subsequently utilised to determine the theoretical importance and sensitivity of the freshwater ecosystems involved. Additionally, the study area was digitally illustrated and mapped utilising Geographical Information Systems (GIS) (e.g. QGIS and/or ArcGIS) to better understand the layout and structure of the surrounding environment and plant site. During this process, all the relevant GIS shapefiles were overlain onto Google Earth Satellite imagery to provide the reader with a holistic view of the study area. **Table 2** below presents the datasets that were utilised, their references and date of publication.

Table 2: Presentation of the datasets and available information that was utilised during the desktop study associated with this assessment.

DATASET/TOOL	SOURCE	RELEVANCE
Catchment data	DWS (2012)	Determine the regional hydrological characteristics of the site (e.g. Mean Annual Precipitation (MAP), Mean Annual Simulated Runoff (MASR), Mean Annual Temperature (MAT) and the general flow direction into, through and out of the study area.
Google Earth Pro™ Imagery	Google Earth Pro™ (2019)	Survey the current and historical imagery of the study area to determine the change in land-use practices, and thus identify potential impacts.

DATASET/TOOL	SOURCE	RELEVANCE
DWS Ecoregions (Geographic Information System (GIS) data)	DWS (2005)	Determine the characteristics of the freshwater resources within the study area.
National Freshwater Ecosystem Priority Areas (NFEPA) river and wetland inventories (GIS coverage)	Council for Scientific and Industrial Research (CSIR) (2011)	Ascertain which freshwater resources have been categorised as important and/or sensitive habitats at a national scale, and thus those that will require conservation.
Aquatic Critical Biodiversity Areas for MP	GDARD (2011)	Ascertain which planning units have been categorised as critically important to maintaining, or achieving the conservation targets at a national scale, and thus those that will require conservation.
South African Geological Map (GIS coverage)	Geological Survey (1988)	Determine the underlying lithostratigraphic units to extrapolate the sub-surface flow movements and the parent material of the hydric soils.
South African national land-cover (GIS coverage)	GeoTerraImage (2015)	To conduct a comparison of what is presented in the dataset against what is currently observed on-site, and thus identify potential disturbance/impacts.
Wetland Vegetation dataset of South Africa	SANBI (2011)	Determine the presumed natural hydrophilic vegetation communities within the study area to ascertain the degree to which the natural cover has been altered by change in land-use practices.

5.3 Visual Inspection

During the fieldwork, a visual investigation of the proposed study area was conducted to identify any on site and upstream impacts, from both the surrounding land-use activities and environmental processes which may have influenced the overall health and functionality of the impacted watercourses. The impacts observed and condition of the study area were photographed, documented and related to professional experience. This essentially provided a baseline for further studies and justify the PES of the impacted watercourses.

5.4 Physicochemical Water Quality Analyses

A field assessment of the watercourses situated within the study area associated with the study area was conducted on the 18th of May 2020. During this field survey, *in situ* water quality analyses were conducted by a suitably qualified ENVASS specialist who was fully trained in implementing the below presented SANAS and ISO protocols and guidelines. At each of the biomonitoring points the ENVASS specialist made use of a hand-held Aquaprobe AP-800 to assess *in situ* water quality parameters such as pH, Dissolved Oxygen (DO), Temperature, Electrical Conductivity (EC), and Total Dissolved Solids (TDS).

The water sampling that was conducted at the biomonitoring sites was done in accordance with the following guidelines:

1. Guidance on the preservation and handling of water samples:
2. **SANS 5667-3:2006/ISO 5667-3:2003 (SABS ISO 5667-3)**
3. Guidance on sampling of rivers and streams:
4. **SANS 5667-6:2006/ISO 5667-6:2005 (SABS ISO 5667-6)**
5. Guidance on quality assurance of environmental water sampling and handling:
6. **SANS 5667-14:2007/ISO 5667-14:1998**

Other Documents that are used are as follow:

1. ENVASS – Standard Operation Procedure (SOP) for the sampling, handing and preservation of surface, ground, potable and sewage water samples.
2. DWAF best practice guideline – G3 – Water Quality Monitoring Programs.

5.5 Index of Habitat Integrity Assessment (IHIA)

Habitat is one of the most important factors that determine the health of river ecosystems since the availability and diversity of habitats (instream and riparian areas) are important determinants of the biota that are present in a river system (Kleynhans, 1996). The 'habitat integrity' of a river refers to the "maintenance of a balanced composition of physicochemical and habitat characteristics on a temporal and spatial scale that are comparable to the characteristics of natural habitats of the region" (Kleynhans, 1996). It is seen as a surrogate for the assessment of biological responses to driver changes.

The Index of Habitat Integrity Assessment (IHIA), 1996, version 2 (Kleynhans, 2012) was used to obtain a habitat integrity class for the instream habitat and riparian zone. This tool compares the current state of the in-stream and riparian habitats (with existing impacts) relative to the estimated reference state (in the absence of anthropogenic impacts). This involved the assessment and rating of a range of criteria for instream and riparian habitat scored individually (from 0-25) using **Table 3** as a guide. This assessment was informed by (i) a site visit where potential impacts to each metric were assessed and evaluated and (ii) an understanding of the catchment feeding the river and land-uses / activities that could have a detrimental impact on river ecosystems.

Table 3: Category of score for the Present Ecological State (PES).

RATING SCORE	IMPACT SCORE	DESCRIPTION
0	A: Natural	No discernible impact or the modification is located in such a way that it has no impact on habitat quality, diversity, size and variability.
1-5	B: Good	The modification is limited to very few localities and the impact on habitat quality, diversity, size and variability are also very small.
6-10	C: Fair	The modifications are present at a small number of localities and the impact on habitat quality, diversity, size and variability are also limited.
11-15	D: Poor	The modification is generally present with a clearly detrimental impact on habitat quality, diversity size and variability. Large areas are, however, not influenced.
16-20	E: Seriously Modified	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.
21-25	F: Critically Modified	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.

The overall riparian and instream integrity of the assessed watercourses was then determined using the categories listed in **Table 4** below.

Table 4: Classification of the Present Ecological State (PES) Classes in terms of Habitat Integrity (Based on Kemper, 1999).

HABITAT INTEGIRTY CATEGORY	DESCRIPTION	RATING (& OF TOTAL)
A	Unmodified, natural.	90-100
B	Largely natural with few modifications. The flow regime has been only slightly modified and pollution is limited to sediment. A small change in natural habitats may have taken place. However, the ecosystem functions are essentially unchanged.	80-89
C	Moderately modified. Loss and change of natural habitat and biota have occurred, but the basic ecosystem functions are still predominantly unchanged.	60-79
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.	40-59
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem functions is extensive.	20-39

HABITAT INTEGIRTY CATEGORY	DESCRIPTION	RATING (& OF TOTAL)
F	Critically / Extremely modified. Modifications have reached a critical level and the system has been modified completely with an almost complete loss of natural habitats and biota. In the worst instances the basic ecosystem functions have been destroyed and the changes are irreversible.	0-19

5.6 Integrated Habitat Assessment System (IHAS)

The Integrated Habitat Assessment System (IHAS) was applied according to the protocol of McMillian (1998) that was modified by Dallas (2005). This provided an indication of the habitat potential/suitability for aquatic macroinvertebrates within the study site. IHAS is not a standalone tool and the results need to be interpreted according to the following guidelines in order to aid with data dissemination. The IHAS index scores were interpreted according to the following guidelines (**Table 5**).

Table 5: Presentation of the classes used to interpret the IHAS results.

IHAS SCORE	INTERPRETATION
<65%	Insufficient for supporting a diverse aquatic macro invertebrate community.
65%-75%	Acceptable for supporting a diverse aquatic macro-invertebrate community.
>75%	Highly suited for supporting a diverse aquatic macro-invertebrate community.

5.7 South African Scoring System Ver. 5 (SASS5)

The South African Scoring System Version 5 (SASS5) methodology is a rapid bioassessment method used to identify changes in species composition of aquatic invertebrates to indicate relative water quality (Dickens & Graham, 2002). SASS5 requires the identification of invertebrates to a family level in the field.

The methodology is based on the principle that some invertebrate taxa are more sensitive than others to pollutants. In particular, macroinvertebrate assemblages are good indicators of localized conditions in rivers. Many macroinvertebrates have limited migration patterns or are not free-moving, which makes them well-suited for assessing site specific impacts of upstream/downstream land-use practices. Benthic macroinvertebrates are abundant in most streams. Even small streams (1st and 2nd order), which may have a limited fish population, will support a diverse macroinvertebrate population. These groups of species constitute a broad range of trophic levels and pollution tolerances, and thus SASS5 is a useful tool for interpreting the cumulative effects of impacts on aquatic environments.

Using a 'kick net', the SASS5 method prescribes specific time-periods and spatial areas for the kicking of in- and out-of-current stones and bedrock (Stones biotope); sweeping of in- and out-of-current marginal and aquatic vegetation, as well as the kicking of the Gravel, Sand and Mud (GSM) biotope followed by visual observations via hand-picking. The results of each biotope are kept separate, until all observations are noted. The entire sample is then returned to the river, retained alive, or preserved for further identification.

In a SASS5 analysis, species abundance is recorded on an SASS5 score sheet which weighs the different taxa common to South African rivers from 1 (pollutant tolerant) to 15 (pollution sensitive). The SASS5 score will be high at a particular site if the taxa are pollution sensitive and low if they are mostly pollution tolerant.

The endpoint of any biological or ecosystem assessment is a value expressed either in the form of measurements (data collected) or in a more meaningful format by summarising these measurements into one or several index values (Cyrus *et al*., 2000). On the SASS5 score sheet, organisms in the trays are identified up to family level, they are then ticked off under the appropriate biotope on the score sheet, and the abundance for each taxon is indicated and the results calculated thereafter. The main indices derived and calculated from the score sheet (to be utilised for data interpretation) are:

- Number of taxa: The total number of different taxa identified within the assessed reach;
- SASS5 score: Obtained from adding the quality or sensitivity scores from each identified taxon on the score sheet; and
- Average Score Per Taxon (ASPT): Obtained from dividing the SASS5 score by the number of taxa identified at the site.

To determine the overall Ecological Category (EC) of each site, the indices calculated for each site were plotted on the standard SASS interpretation guideline graphs relevant to the ecoregion in which each biomonitoring site was recorded to fall. These interpretations were modelled for each ecoregion using available SASS data, which was extracted from the River Health Programme (RHP) database and other external sources. Ecoregions were broken down further into simplified longitudinal zones based on differentiation into upland and lowland sites (Dallas, 2007). These interpretation guidelines were utilised as a reference condition during the analyses of the data gathered during the field survey. The modelled reference conditions relevant to the study ecoregion (i.e. Highveld- Lower) are presented in **Table 6** for ease of reference (Dallas, 2007).

Table 6: Classification protocol for determining the Present State Class as modelled for the Highveld- Lower ecoregion (Dallas, 2007).

ECOLOGICAL CATEGORY	DESCRIPTION	SASS5 SCORE	ASPT
A	Natural/unmodified: Unimpaired community structures and functions comparable to the best situation to be expected. Optimum community structure for stream size and habitat quality.	142 - 200	7.3 - 9.0
B	Good: Largely natural with few modifications. A small change in community structure may have taken place but ecosystem functions are essentially unchanged	110 - 141	6.6 – 7.2
C	Fair: Moderately modified with fewer families present than expected, due to loss of most intolerant forms. Basic ecosystem functions have changed.	87 - 109	5.9 – 6.5
D	Poor: Largely modified with few aquatic families present, due to loss of most intolerant forms. An extensive loss of basic ecosystem functions has occurred.	52 - 86	5.2 – 5.8
E/F	Seriously Modified with few aquatic families present. If high densities of organisms, then dominated by a few taxa. Only tolerant organisms present.	0 - 51	0 – 5.1

6 DESKTOP ASSESSMENT

The following sections consist of information obtained during the desktop study of with the study area the surrounding aquatic environment.

6.1 Hydrological Setting

The study area was observed to fall within quaternary catchment B20A, within the Upper Olifants Sub-Water Management Area (WMA) of the greater Olifants WMA (**Figure 2**). The proposed development was recorded to traverse two (2) Sub-Quaternary Reaches (SQRs) namely B20A-1298 and B20A- 3208, which were both calculated to have a Present Ecological State (PES) score falling within Class D (Largely modified) and be of a high Ecological Importance and Ecological Sensitivity within the broader catchment area..

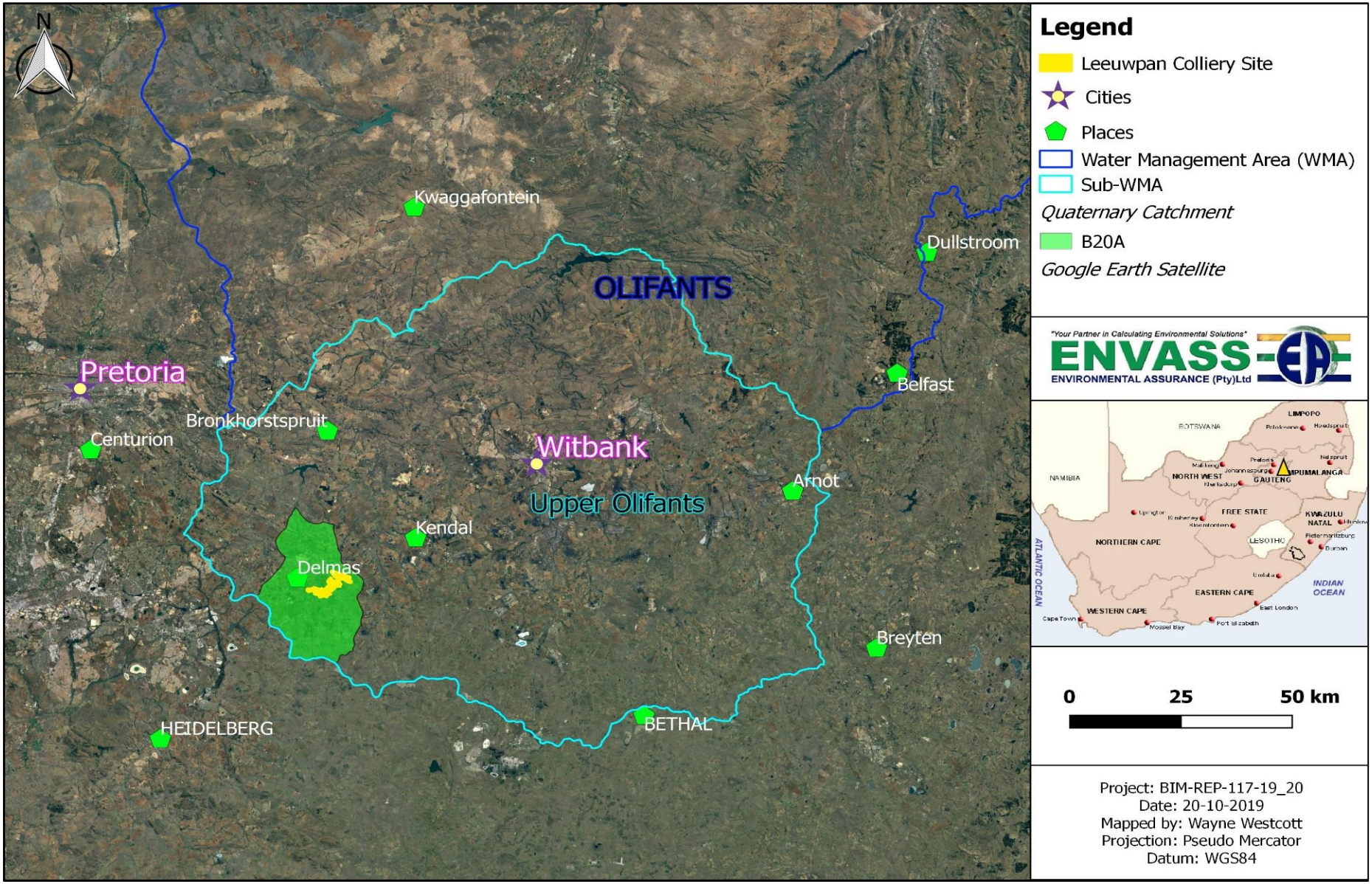


Figure 2: Illustration of the quaternary catchment area and Water management Areas (WMAs) that were associated with the study area (DWS, 2012).

6.2 Ecoregion

According to the delineation provided by Dallas (2005), the level 1 ecoregion associated with the study area is the Highveld ecoregion (no. 11) (**Figure 3** & **Table 7**). The Highveld ecoregion is characterised by plains of moderate to low relief composed of various grassland vegetation types (Kleynhans *et al*., 2005). Low to moderately high Mean Annual Precipitation (MAP), with hot to moderate mean annual temperatures. The ecoregion covers 163,645 square km.

Table 7: Main attributes associated with the Highveld Ecoregion.

MAIN ATTRIBUTES	HIGHVELD
Terrain Morphology: Broad division (dominant types in bold) (Primary)	**Plains: low relief** **Plain: moderate relief** Lowlands: Hills and mountains, moderate and high relief Open hills: Lowlands; mountains, moderate to high relief Closed hills: Mountains, moderate and high relief
Vegetation types (dominant types in bold) (Primary)	Mixed Bushveld (limited) Rocky Highveld Grassland; **Dry Sandy Highveld Grassland**; Dry Clay Highveld Grassland; **Moist Cool Highveld Grassland**; Moist Cold Highveld Grassland; North Eastern Mountain Grassland; Moist Sandy Highveld Grassland; Wet Cold Highveld Grassland (limited); Moist Clay Highveld Grassland; Patches Afromontane Forest (very limited)
Metres Above Mean Sea Level (MAMSL) (secondary)	1100-2100 & 2100-2300 (very limited)
MAP Millimetres (mm) (modifying)	400 to 1000
Coefficient of Variation (% of annual precipitation)	<20 to 35
Rainfall Concentration Index	45 to 65
Rainfall Seasonality	Early to late summer
Mean Annual Temperature (MAT) (°C)	12 to 20
Mean Daily Max. Temp. (MDMT) (°C): February	20 to 32
MDMT (°C): July	14 to 22
Mean Daily Min. Temp. (°C): February	10 to 18
Mean Daily Min Temp. (°C): July	-2 to 4
Median Annual Simulated Runoff (MASR) (mm) for quaternary catchment	5 to >250

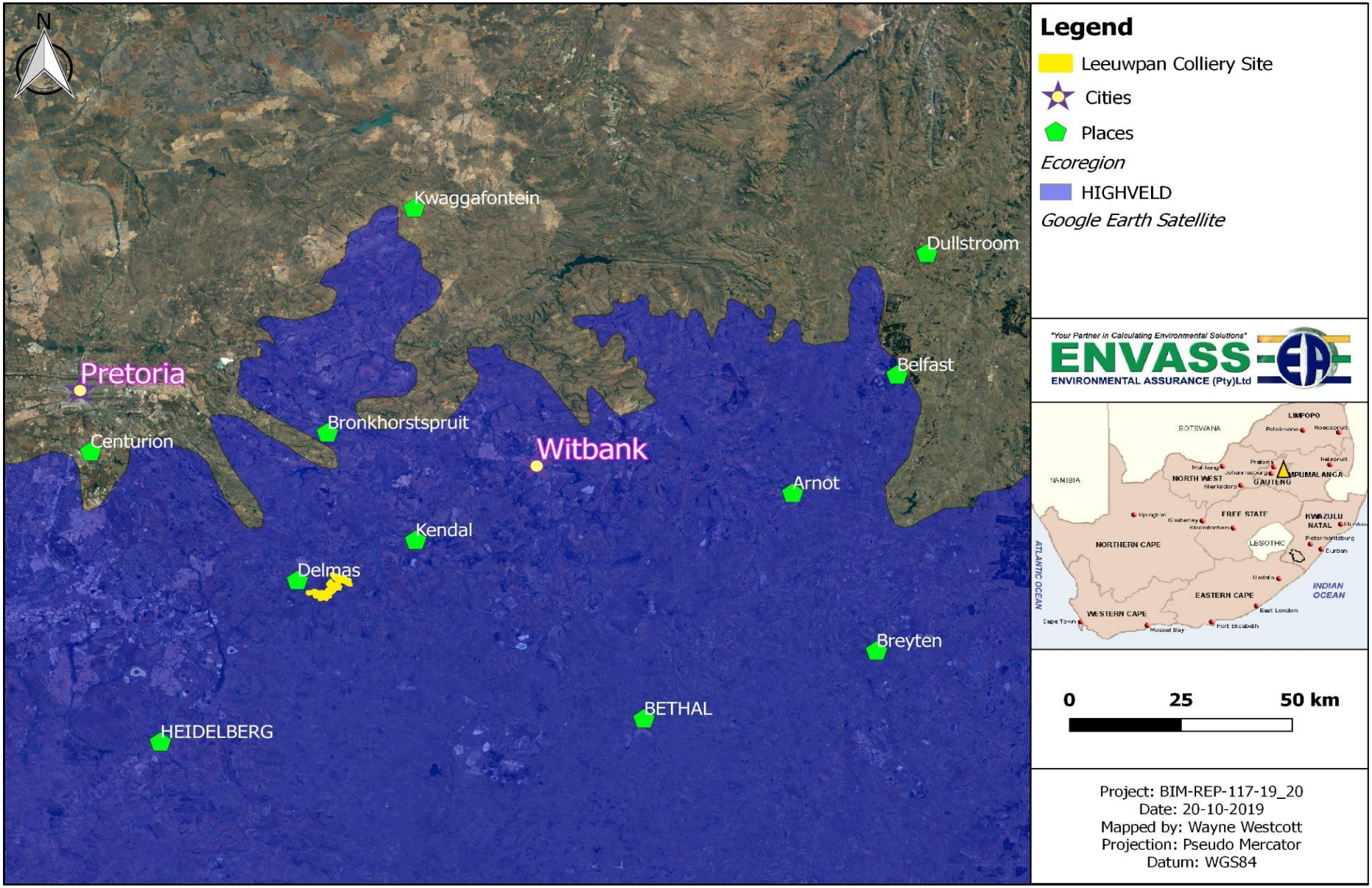


Figure 3: Ecoregion associated with the study area (DWS, 2012).

6.3 Sub-Quaternary Reaches (SQRs)

The study area was recorded to be situated in the B20A quaternary catchment area. According to Department of Water and Sanitation (DWS) (1996) the study area extended into the B20A- 1298 and B20A- 1308 Sub-Quaternary Reaches (SQRs) of the Highveld ecoregion.

Table 8 below summarises the characteristics that have been recorded for the following SQRs:

- Bronkhorstspruit SQR B20A- 1298, which contains the following sites:
  - LP-RK-DS (Tox);
  - LP-RK-Wet1;
  - L-Pan;
  - LP-RK-Wet2;
  - LP-RK-US;
  - D-US;
  - D-DS (Tox);
  - LP-WEL-US;
  - LP-WEL-DS (Bio)
- SQR B20A- 1308, which contains the following sites:
  - BS-WET;
  - LP-BS-DS (Bio);
  - LP-BS-US; and
  - LSW09 (Tox).

Table 8: Characteristics of the Sub-Quaternary Reaches (SQRs) associated with the biomonitoring points.

CHARACTERISTICS	SUB QUATERNARY REACH (SQR)	
	B20A- 1298	B20A- 1308
River Association:	Bronkhorstspruit	N/A
Reach Length (km):	31.39	14.98
Present Ecological State (PES):	Largely Modified (Class D)	Largely Modified (Class D)
Ecological Importance:	Moderate	Moderate
Ecological Sensitivity:	Moderate	Moderate
Stream Modification:	Moderate	Moderate
Recommended Ecological Category (REC)	Moderately Modified (Class C)	Moderately Modified (Class C)

CHARACTERISTICS	SUB QUATERNARY REACH (SQR)	
	B20A- 1298	B20A- 1308
Anthropogenic impacts:	**SMALL/LIMITED:** Canalization, Chicken farms, Inundation **MODERATE:** Crossings, low water, Exotic Vegetation, Mining, Runoff/effluent: Mining, Small dams, trampling, Vegetation removal **LARGE:** Abstraction (run-of river)/increased flows, Irrigation, Roads, Runoff/effluent: Irrigation **SERIOUS/ABUNDANT:** Agricultural lands	**SMALL/LIMITED:** Crossings, low water, Fire (rated if site is burnt), Inundation, Roads, Small dams (farm). **MODERATE:** Algal growth, Bed stabilisation, Exotic vegetation, Runoff/effluent: Mining, trampling. **LARGE:** Abstraction (run-of river)/increased flows, Irrigation, Mining, Runoff/effluent: Urban areas, Vegetation removal. **SERIOUS/ABUNDANT:** Agricultural lands.

Table 9 below presents the fish species that are expected to occur within the SQRs associated with the study area, as well as their IUCN conservation status category (IUCN, 2018). No Species of Conservation Concern (SCC) were expected within the SQRs associated with the study area.

Table 9: Fish species that could occur within the two SQRs associated with the study area (DWS, 2014; IUCN, 2020; Skelton, 2001).

SCIENTIFIC NAME	COMMON NAME	IUCN STATUS	B20A- 1298 & 1308
Cyprinus carpio	Common Carp	E (VU)	X
Enteromius anoplus	Chubbyhead Bard	LC	X
Enteromius neefi	Sidespot Barb	LC	X
Enteromius pallidus	Goldie Barb	LC	X
Enteromius trimaculatus	Threespot Barb	LC	X
Labeobarbus marequensis	Lowveld Largescale Yellowfish	LC	X
Labeobarbus polylepis	Bushveld Smallscale Yellowfish	LC	X
Pseudocrenilabrus philander	Southern Mouthbrooder	LC	X
Tilapia sparrmanii	Banded Tilapia	LC	X
		Total number of fish species	**9**

KEY: E- Exotic Species, VU-Vulnerable and LC- Least Concern

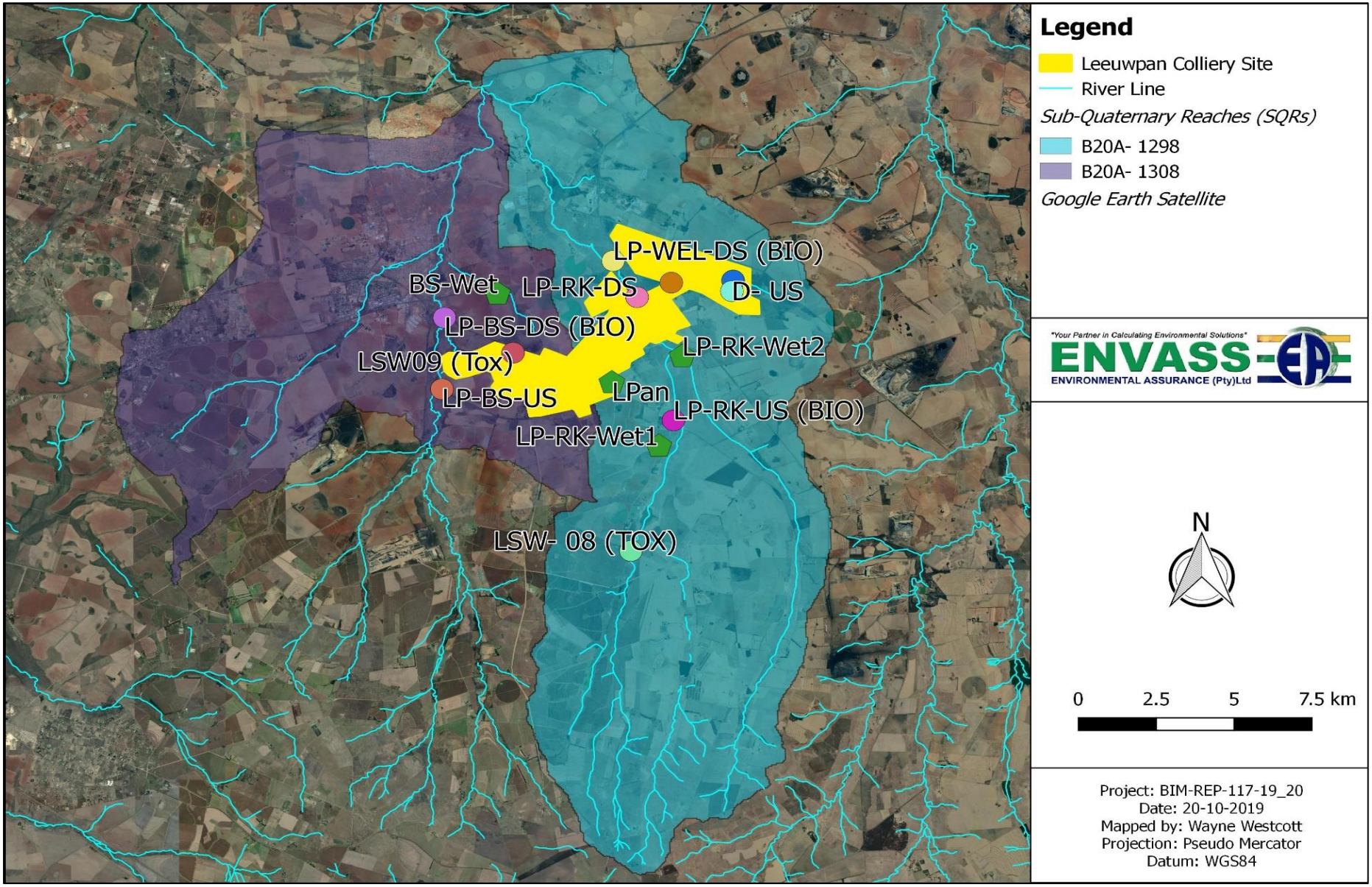


Figure 4: Illustration of the SQRs that are relevant to the biomonitoring sites within the study area.

6.4 Land Use

The dominant land cover associated with the study area were recorded to be; commercial cultivated lands- field and pivots, disturbed grassland urban villages/residential (**Figure 5**). Subsequent to conducting a field survey it was recorded that the majority of the desktop modelled land cover classes were correct, aside from the extent of mining within the SQRs which was observed to encompass a larger portion.

6.5 Vegetation

Vegetation types were identified and delineated on a national scale by Mucina and Rutherford (2006), and this terrestrial vegetation delineation has since been continually modified at five (5) year intervals to account for changes in land cover. The most recent version of the dataset at the time of this study was from 2018. As this delineation was at a national scale, the refined terrestrial vegetation dataset was used as a broad baseline against which the on-site land cover and vegetation condition was compared to in order to determine whether changes had occurred on-site.

According to the most recent SANBI (2006-2018) delineation, the study area was recorded to extend into three (3) vegetation types, namely: Soweto Highveld Grassland, Eastern Highveld Grassland and the Rand Highveld Grassland with the majority falling within the Eastern Highveld Grassland (**Figure 6**). All of the aforementioned terrestrial vegetation types were recorded to have been categorised as endangered by SANBI (2006-18). It must however be noted that the condition of all of the aforementioned vegetation types varies according to the degree to which the changing land-use practices within and surrounding the study site have encroached into the overall delineated boundaries, and thus this has altered the desktop delineated vegetation units. The entire footprint of the Leeuwpan Colliery, aside from approximately 10 % towards the north east of the study area, was recorded to have been converted to mine and associated infrastructure. The surrounding lands were observed to be agriculture or degraded grassland encroached upon by several Invasive Alien Plant Species (IAPS).

Figure 7 below presents the wetland vegetation types that were delineated by Driver et al. (2011) within the study area. The site was observed to fall within the Mesic Highveld Grassland Groups 3 and 4, both of which were categorised as critically endangered. Although the near natural extents of the wetland within the study area were recorded to have been significantly altered by land-use change, the remaining hydrophytic floral communities present in the remaining wetlands were observed to have been moderately diverse in species.

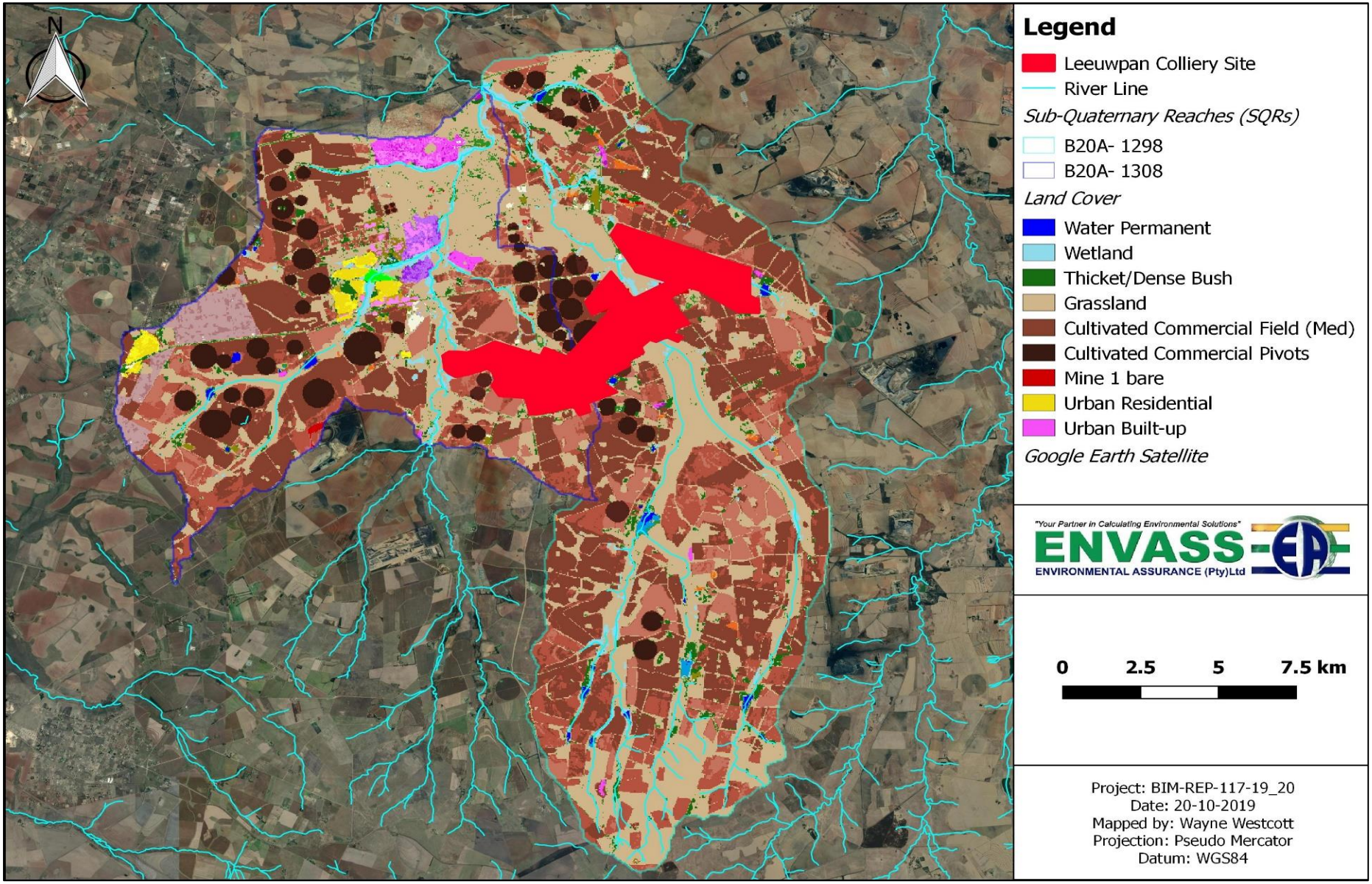


Figure 5: Land cover associated with the proposed development study area (SANBI, 2013/14).

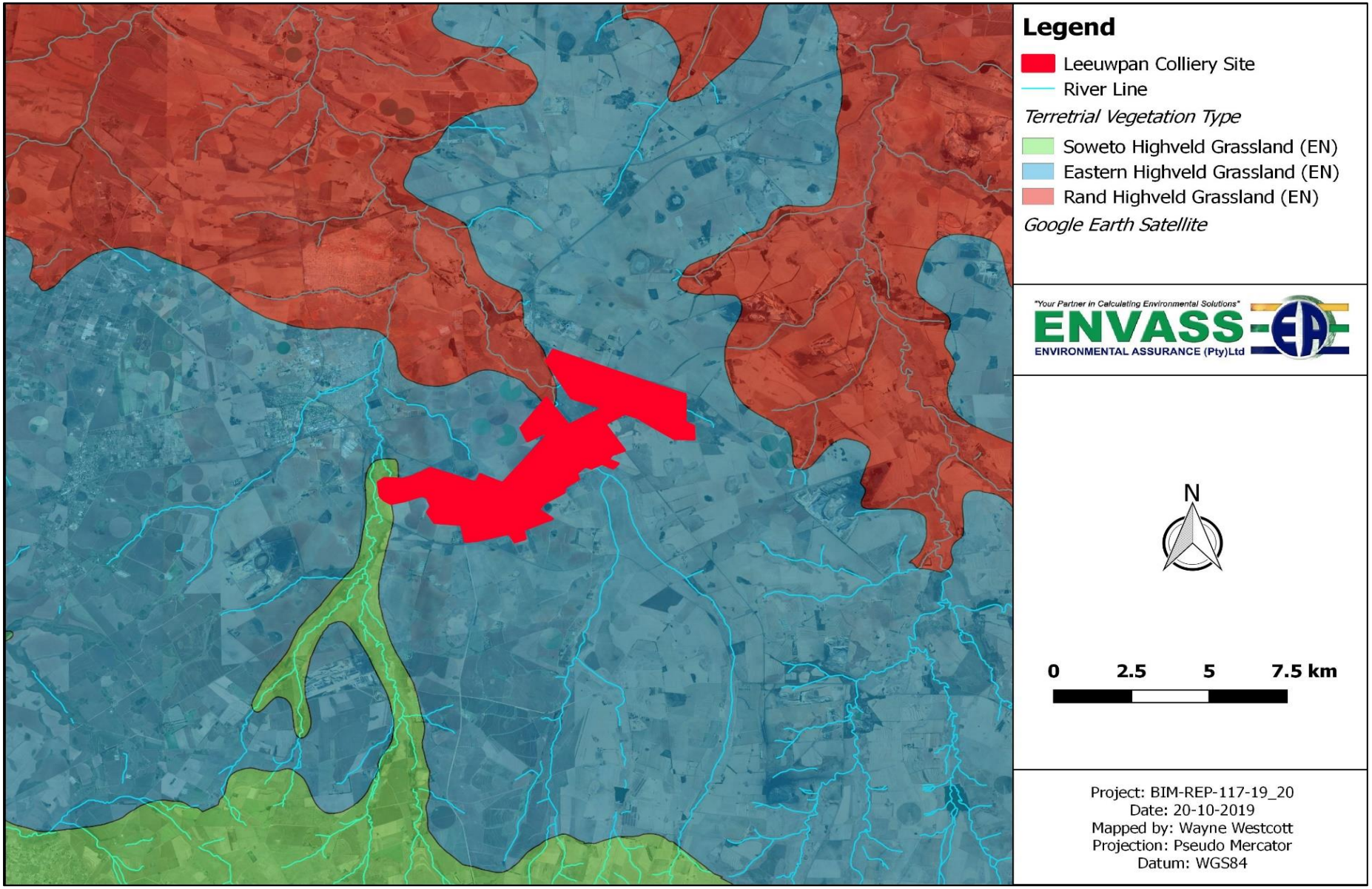


Figure 6: Terrestrial vegetation types associated with the proposed development study area (SANBI, 2006-2018).

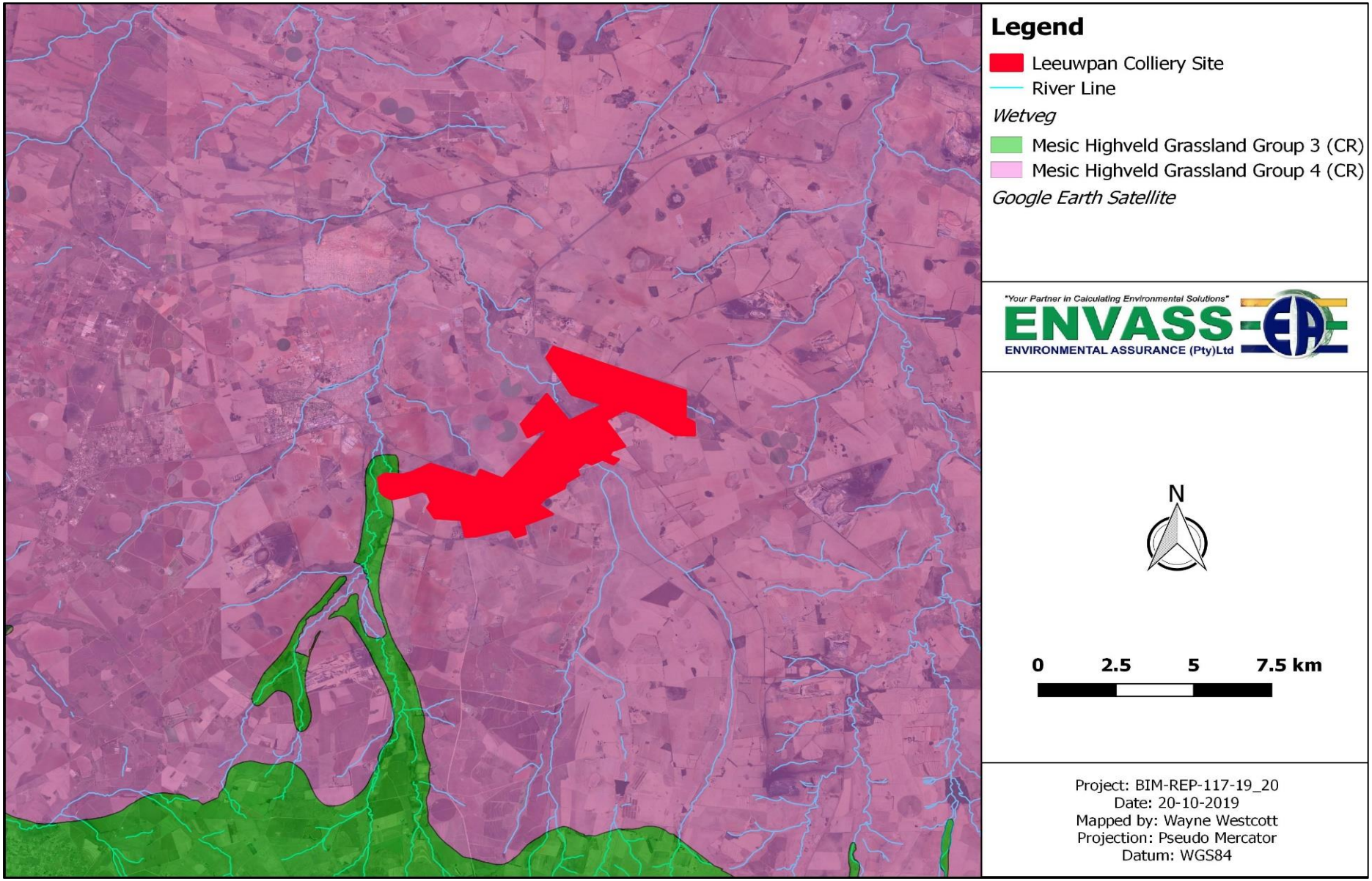


Figure 7: Illustration of the wetland vegetation types and their conservation status relevant to the study area.

6.6 Conservation Plan: Mpumalanga Province

Biodiversity sector plans have been drafted by the Mpumalanga Parks Board (MPCP, 2006) to provide spatial planners with knowledge of an area through a simplified guide to systematic conservation assessments. Critical Biodiversity Areas (CBA) and Ecological Support Areas (ESA) buffers have been developed to outline areas of conservation concern. CBAs are areas which are irreplaceable often providing essential habitat for particular species (MBCP, 2006). A buffer of 100 m is recommended for any proposed activities in relation to CBA. ESAs are areas which provide ecological support to CBA, offering forage or often act as movement corridors for sensitive species, these include fish sanctuaries and registered freshwater and Wetland National Freshwater Ecosystem Priority Areas (NFEPAs) (MBCP, 2006; Driver *et al*., 2011). A buffer of 30 m is often recommended for ESAs (MBCP, 2006).

The entire study area was recorded to fall within either conservation areas that have been categorised as least concern, or areas that have no natural habitat remaining (MBCP, 2006) (**Figure 8**). However, there are areas of high significance in terms of meeting conservation targets situated approximately 4 km downstream. Therefore, it is essential that the upstream activities within the study area be strictly monitored and if seen to be potentially harmful, remediated appropriately.

6.7 National Freshwater Ecosystem Priority Areas (NFEPAs)

The NFEPA database provides strategic spatial priorities for conserving South Africa's freshwater ecosystems and supporting sustainable use of water resources. NFEPAs were identified based on a range of criteria dealing with the maintenance of key ecological processes and the conservation of ecosystem types and species associated with rivers, wetlands and estuaries (Driver *et al.,* 2011). Subsequent to an analysis of the NFEPA river and wetland datasets, at a desktop level and during a field assessment, it was recorded that seventeen (17) NFEPA wetlands were recorded to be within the direct boundary of the Leeuwpan Colliery, all of which were determined to be natural. Two (2) NFEPA river systems were also noted to flow through and in close proximity to the study area, namely the Bronkhorstspruit and its unnamed tributary flowing in from the south (**Figure 9**). The majority of the wetlands within the Leeuwpan Colliery boundary have been mined extensively, however fragmented remnants of the natural system are evident in sparse areas.

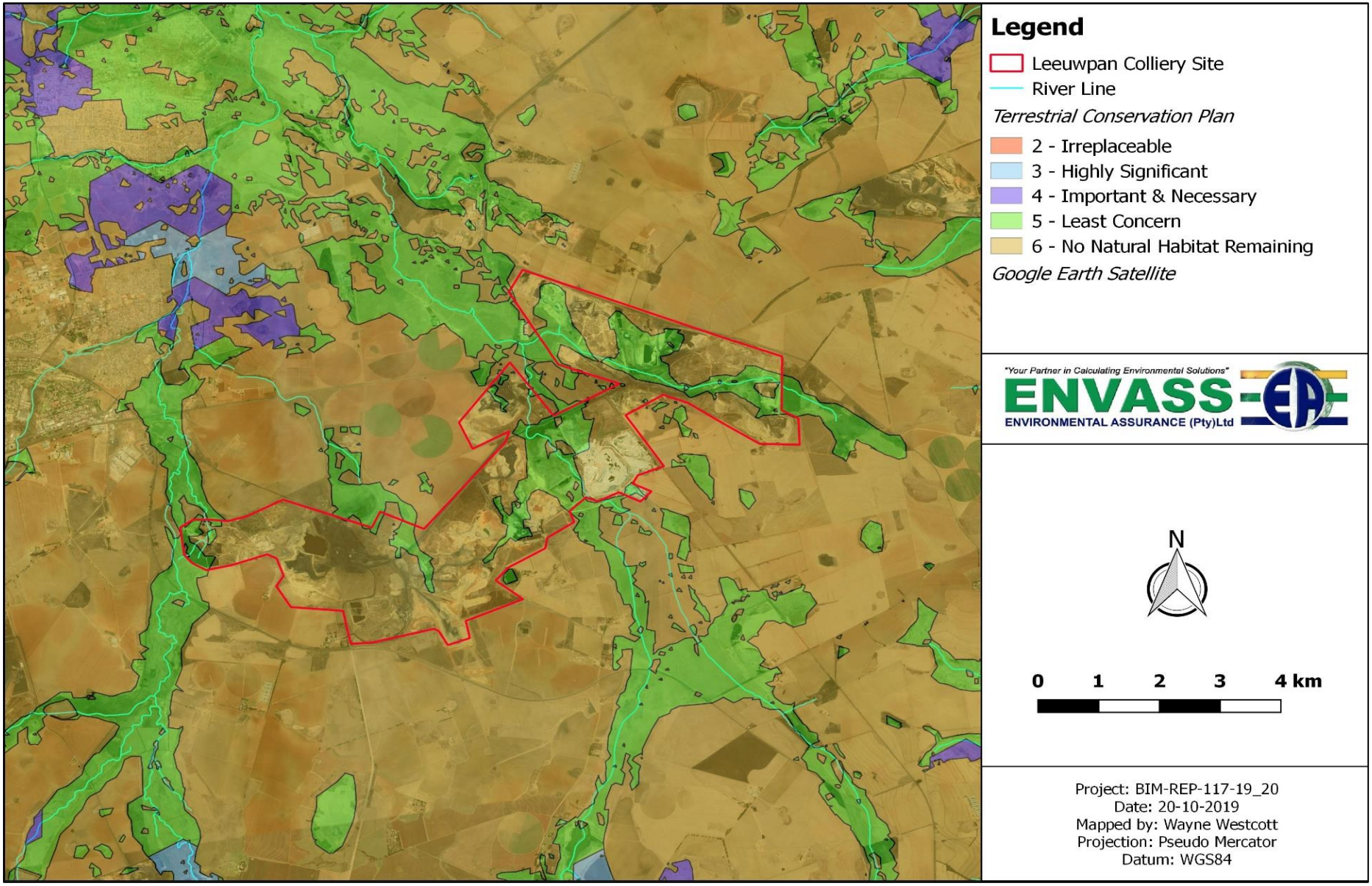


Figure 8: Terrestrial Conservation Units that were determined to be relevant to the study area (MBCP, 2006).

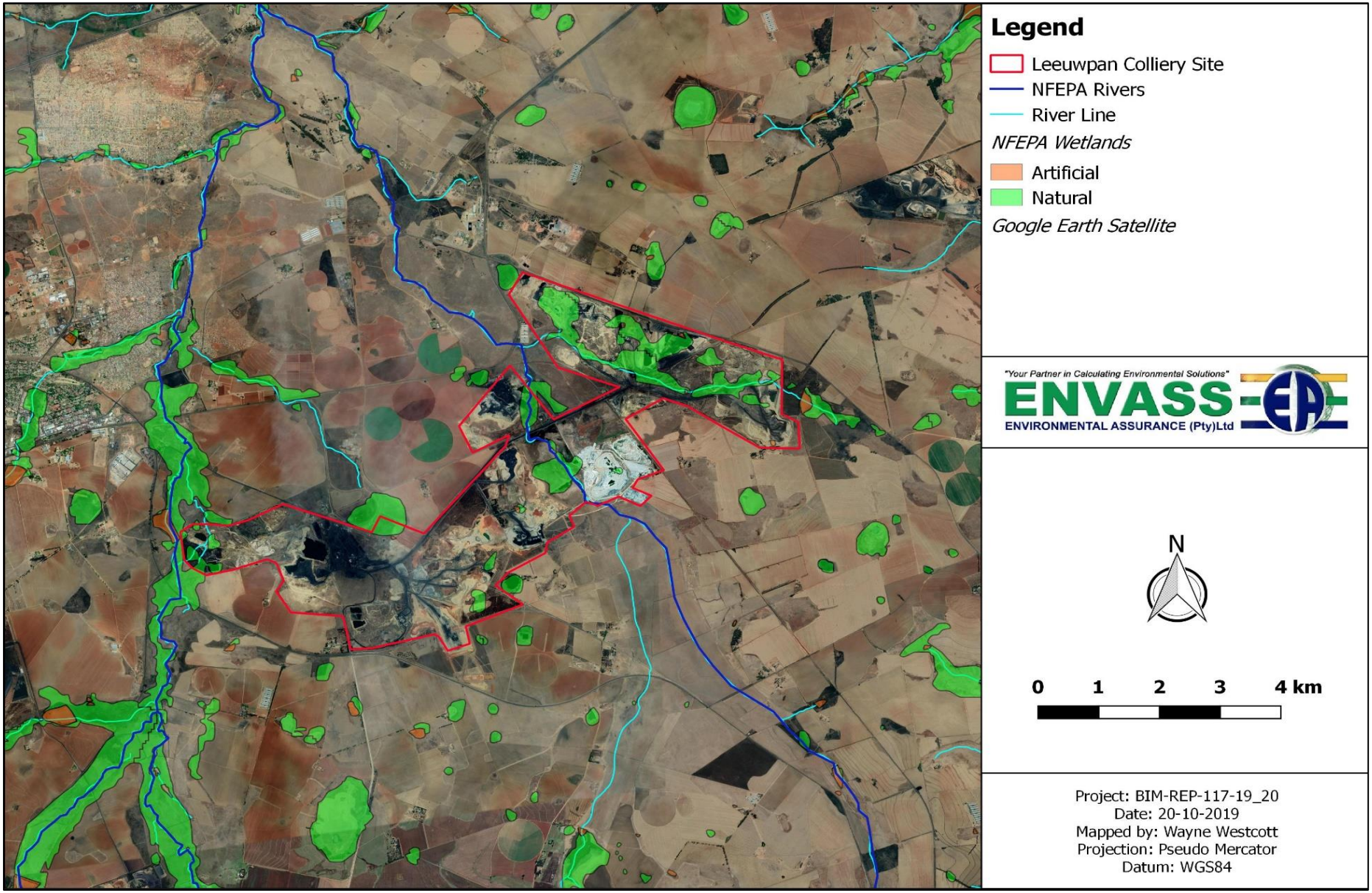


Figure 9: Illustration of the NFEPA wetland and river systems that were recorded within and around the study area (Driver *et al*., 2011).

6.8 Geology and Soils

Figure 10 below illustrates the geological units that were recorded to be underlying the study area, and consequently providing the parent material from which the overlying soils were created. It was evident that the study area was underlain by three (3) lithostratigraphic units, namely the Vryheid Formation, Malmani Sub-group and the Dwyka Group (Council for Geoscience, 2008). The Vryheid Formation is comprised of fine-to-coarse grained sandstone, shale and coal seams, the Malmani Subgroup is dominated by dolomite, subordinate chert, minor carbonaceous shale, limestone and quartzite. The Dwyka Group can be described as a mixture of diamictite with varved shale and mudstone. The shale and mudstone parent material are the primary justification for the high runoff potential of the soil forms, as it would have weathered to form impermeable clay layers with intrusions of quartzite and coal and shale.

Figure 11 below illustrates the soil groups that were recorded to be within the study area. It is evident that hydrological soil Class C formed the majority of the material overlying the abovementioned lithostratigraphic units, with a small section of Class C/D situated in the south western corner of the study area. Hydrological soil Class C demonstrates moderately high inherent runoff potential as a result of slow infiltration rates and restricted permeability, and Class C/D was characterised as having high inherent runoff potential. This can be attributed to Class C/D having very slow infiltration and severely restricted permeability with a high shrink-swell potential. This coupled with the impermeable sub-terrain geologies may result in subsurface flow occurring within and/or above the B soil horizon during and subsequent to heavy rainfall events.

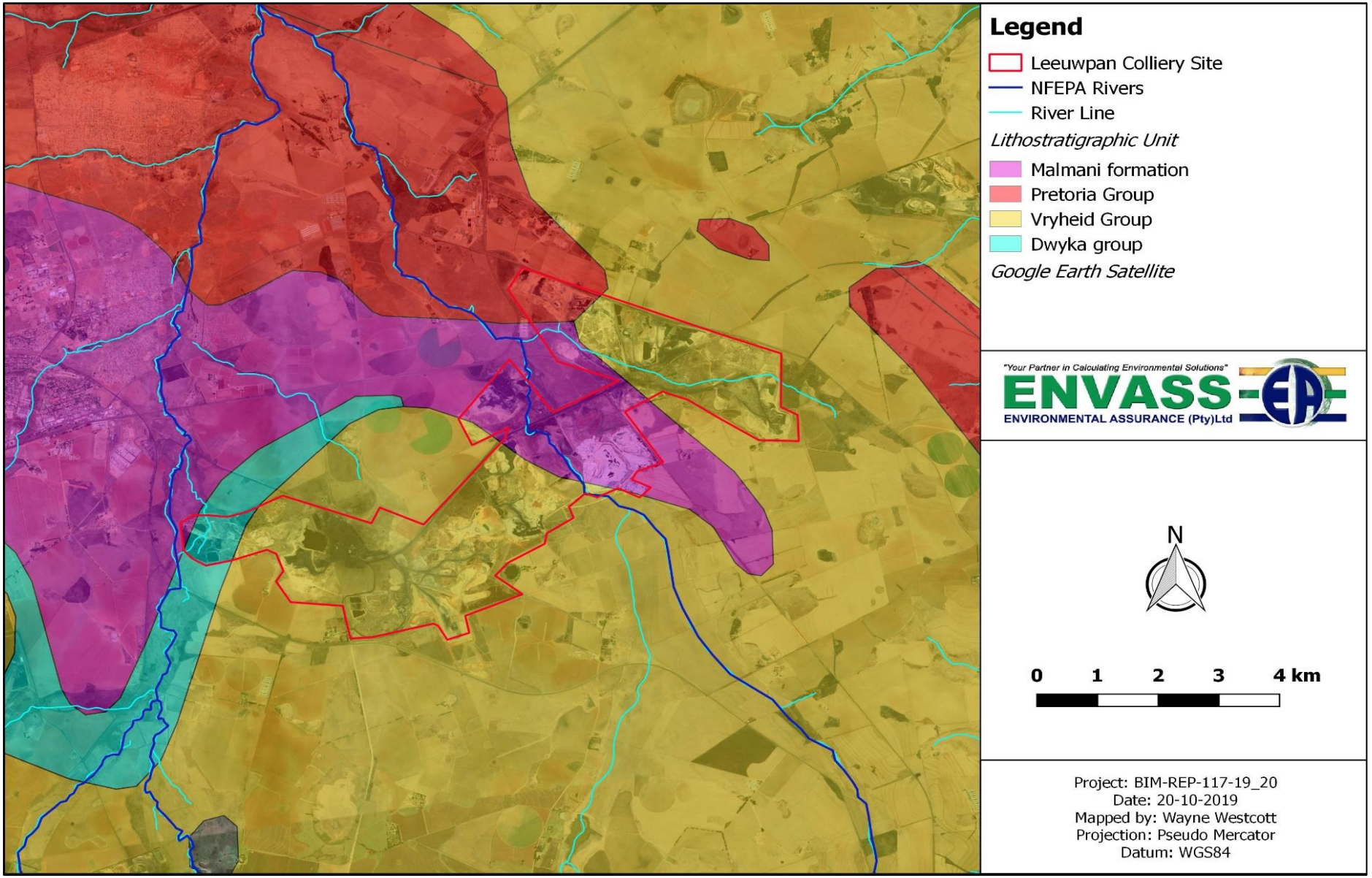


Figure 10: Illustration of the lithostratigraphic units that were recorded within the study area (Council of Geoscience, 2008).

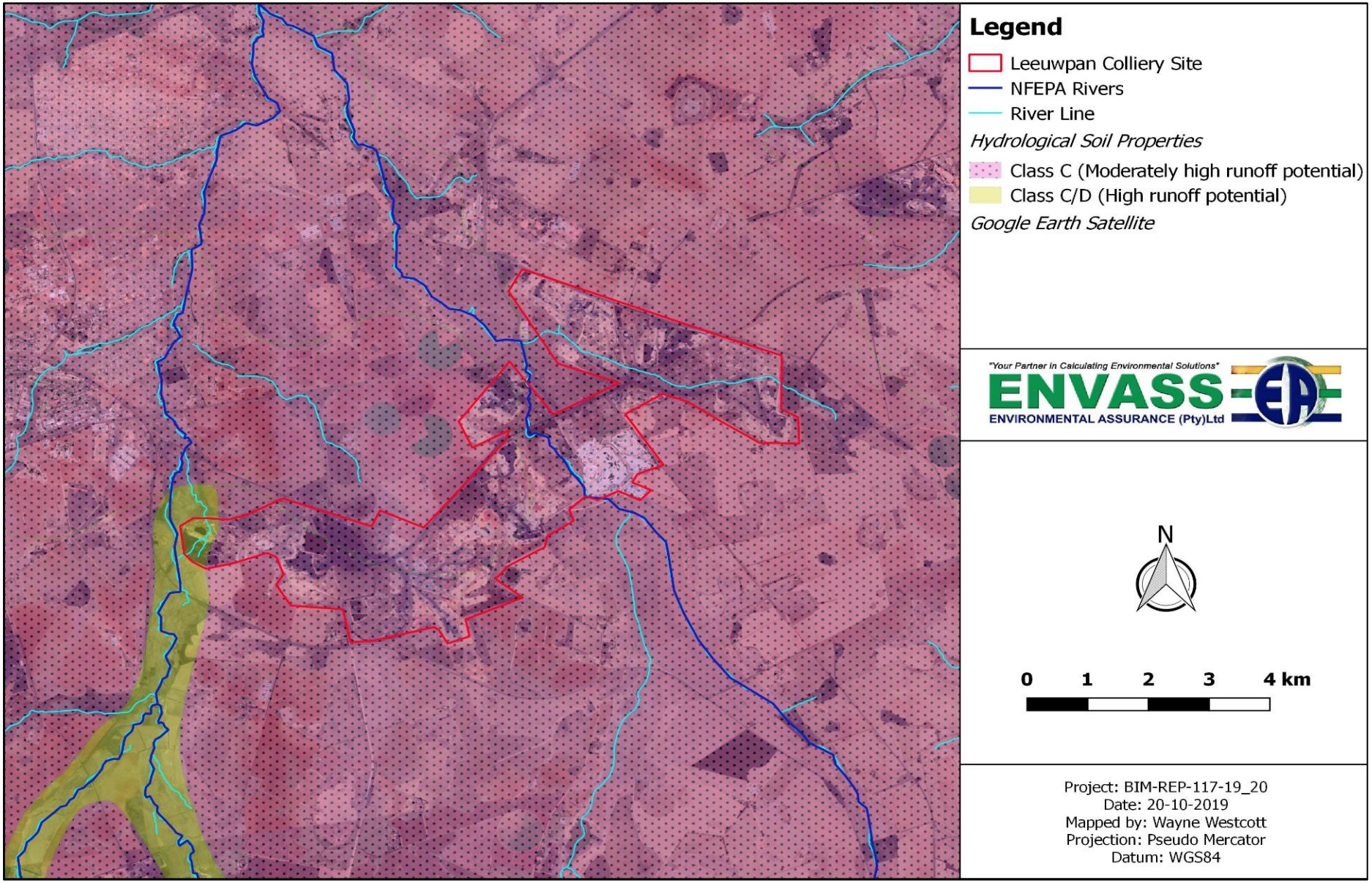


Figure 11: Illustration of the hydrological runoff potential of the soil forms within the study area.

7 BIOMONITORING SAMPLE SITES

Four (4) biomonitoring predetermined sites were selected on representative aquatic systems up and downstream of the study site (**Figure 12**). These sample points were presumably chosen as a result of; 1) their vicinity to the study area and 2) their ability to represent the various biotopes/habitats that are required for the SASS5 and IHAS methodologies. A brief summary of the points is presented below followed by **Tables 10** to **13**, which describe and present each site according to the observations that were made during the field survey, dated the 18th May 2020. It must be noted that these sites are only relevant to the dry season surveys, as additional sites will be assessed during the wet season survey. This can be attributed to the non-perennial nature of the sites having the potential to significantly skew results in certain abnormal drought years specifically experienced in the region.

Bronkhorstspruit SQR no. B20A- 1298:

- **LP-WEL-DS:** Downstream of the Leeuwpan Colliery on a Weltevreden Tributary**.** SASS5, IHAS, Diatom analysis and toxicity testing were conducted at this site;
- **LP-RK-US:** Upstream of the Leeuwpan Colliery on a Rietkuil Tributary. This site indicated stagnant conditions during the 2020 dry season field survey, the Diatom analysis and toxicity testing were conducted at this site at a small pool.

SQR no. B20A- 1308:

- **LP-BS-DS:** Downstream of the Leeuwpan Colliery on the Bronkhorstspruit River. SASS5, IHAS, Diatom analysis and toxicity testing were conducted at this site; and
- **LP-BS-US:** Upstream of the Leeuwpan Colliery on the Bronkhorstspruit River. SASS5, IHAS, Diatom analysis and toxicity testing were conducted at this site.

Quarterly DEEEP Toxicity Testing Sites:

- **KR01A:** Kenbar Return Water Dam (RWD), which replaces the mined-out D-DS site;
- **D-DS (LSW13):** Divergent channel 3 on-site, which flows into a Weltevreden Tributary and then into the downstream Bronkhorstspruit River; and
- **LSW09:** Pollution Control Dam (PCD) on-site.

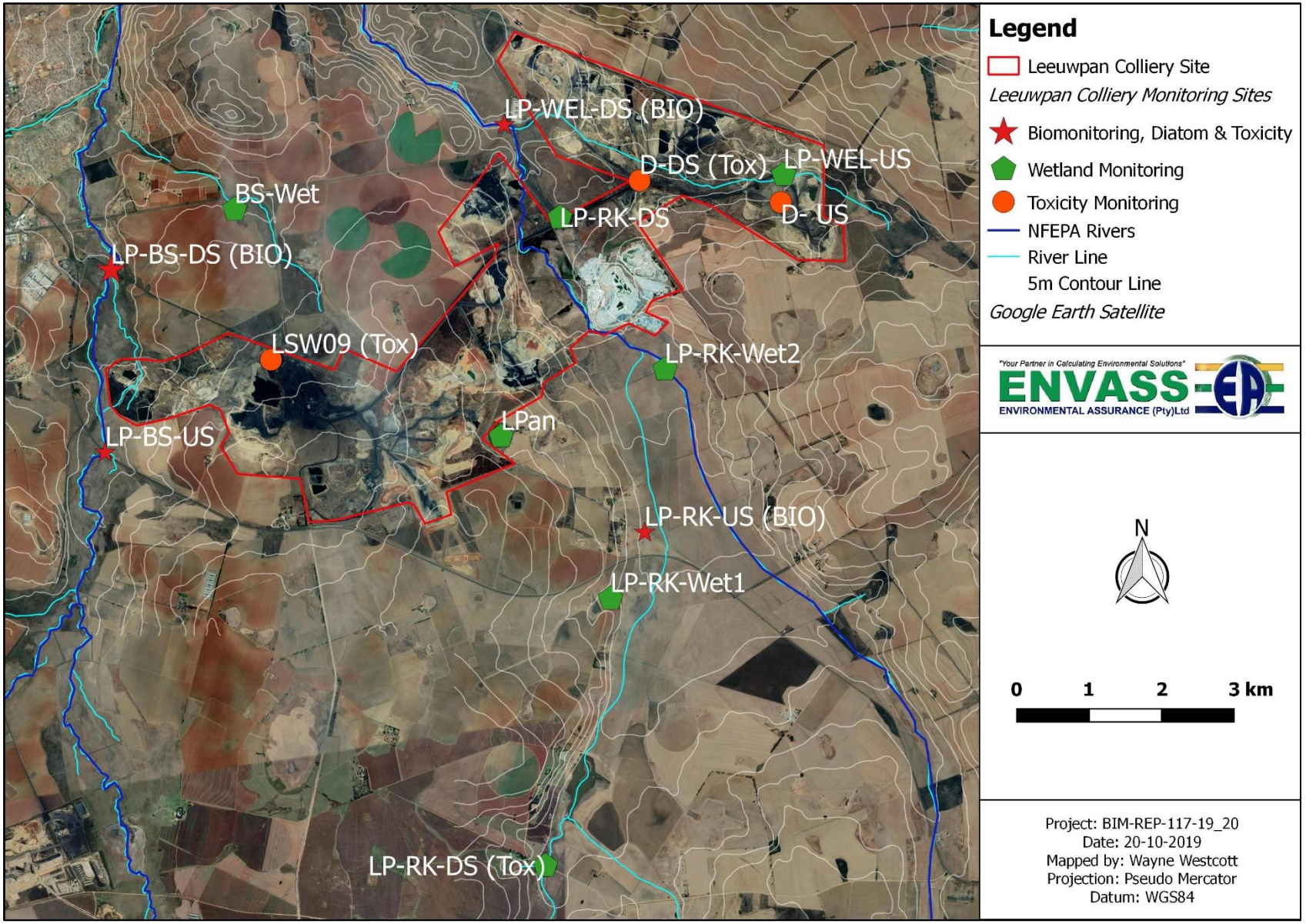


Figure 12: All monitoring sites relevant to the Leeuwpan Colliery. Only the biomonitoring sites were relevant to this dry season study.

7.1 Description of the Biomonitoring Points

A brief description of the biomonitoring sites is summarised in **Tables 10** to **13** below.

Sites within the Bronkhorstspruit SQR no. B20A- 1298

Table 10: Site characteristics recorded within the assessed reach at the LP-WEL-DS site.

LP-WEL-DS: DOWNSTREAM POINT ON A WELTEVREDER TRIBUTARY	
Upstream	**Downstream**
	
Site Description	The site was situated upstream of the Leeuwpan Colliery above a railway bridge and associated road-crossing. A chicken abattoir was located upstream of the sites on the northern bank.
GPS Coordinates	Latitude: 26° 8' 14.28" S Longitude: 28°45' 24.84" E
Meters Above Sea Level (masl)	1547
Quaternary Catchment	B20A
Ecoregion (Level 1	Highveld- Lower
Riparian Vegetation Species	No riparian area was recorded; however, the fringes of the active channel were populated with, among others; *Juncus spp*. *Phragmites australis*, *Cyperus dives* and *C. latifolius*.
Geomorphological Zonation	Lower Foothill
Channel Classification	2nd Order 'C' Channel Stream (Perennial) this can be attributed to additional flow-inputs from attenuated stormwater.
Channel Dimensions	Assessed Reach 50m; Channel width 2 – 3 m; Depth 0.4 – 1.1 m
Water Turbidity	Low
Water Flow Velocity	Low

LP-WEL-DS: DOWNSTREAM POINT ON A WELTEVREDER TRIBUTARY	
Upstream	**Downstream**
Water Colour	Discoloured
% Algae or Other Litter	20 % algae, medium abundance of organic matter on stream bed.
Other Biota	Tadpoles
Description of Disturbances	Regular sedimentation from the surrounding agricultural and mining activities, stormwater runoff, flow impediment and confinement from the railway-crossing, excess water uptake from Invasive Alien Plant Species (IAPS), as well as increased nutrient input from the upstream chicken abattoir via surface-wash.

Table 11: Site characteristics recorded within the assessed reach of upstream LP-RK-US.

LP-RK-US: UPSTREAM POINT ON A RIETKUIL TRIBUTARY	
Upstream	**Downstream**
	
Site description	Situated approximately 400 m upstream of a farm dam, above a gravel road-crossing. Agricultural practices were observed to dominate its catchment area.
GPS Coordinates	Latitude: 26°13'44.76"S Longitude: 28°45'45.36"E
Meters Above Sea Level (masl)	1573
Quaternary catchment	B20A
Ecoregion (Level 1)	Highveld- Lower
Riparian Vegetation Species	Void of riparian vegetation, aside from sparsely distributed sugarcane shoots.
Geomorphological Zonation	Lower Foothill

LP-RK-US: UPSTREAM POINT ON A RIETKUIL TRIBUTARY	
Upstream	**Downstream**
Channel Classification	1st Order 'B' Channel Stream (non-perennial)
Channel Dimensions	Assessed Reach 50m; Width 2 – 5 m; Depth in flow 0.15 – 0.6 m
Water Turbidity	No flow / stagnant – Moderate
Water Flow Velocity	No flow
Water Colour	No flow / stagnant – opaque
% Algae or Other Litter	Excess algal growth in stagnant pool (70%)
Other biota	None
Description of Disturbances	Significant clearance of riparian and adjacent vegetation had occurred within the assessed reach presumably to clear land for croplands. Gravel roads impeded and confined flow and the land clearing had reduced the friction against surface water flow downgradient, and thus increased the erosion potential of the site.

Sites within the SQR no. B20A- 1308

Table 12: Site characteristics recorded within the assessed reach at site LP-BS-US.

LP-BS-US: UPSTREAM SITE ON THE BRONKHORSTSPRUIT RIVER	
Upstream	**Downstream**
	
Site Description	Upstream of the Leeuwpan Colliery at a point where the R50 Road crosses the Bronkhorstspruit River. The assessed reach spanned from above the bridge-crossing to 20m downstream of it. Agriculture dominated the minor catchment area.

LP-BS-US: UPSTREAM SITE ON THE BRONKHORSTSPRUIT RIVER	
Upstream	**Downstream**
GPS Coordinates	Latitude: 26°10'40.44"S Longitude: 28°42'6.48"E
Meters Above Sea Level (mamsl)	1557
Quaternary Catchment	W13B
Ecoregion (Level 1)	Highveld- Lower
Geomorphological Zonation	Lower Foothill
Channel Classification	2nd Order, 'B' Channel Stream (non-perennial)
Water surface dimensions	Assessed Reach 50 m; Width 4 – 15 m; Depth in flow 0.3 – 1.1 m
Water Turbidity	Low
Water Flow Velocity	Low
Water Colour	Slightly opaque
% Algae and Other Litter	30 %
Other Biota	None
Description of Disturbances	Significant clearance of riparian and adjacent vegetation had occurred within the assessed reach presumably to clear land for agricultural practices. Gravel roads impeded and confined flow and the land clearing had reduced the friction against surface water flow downgradient, and thus increased the erosion potential of the site. Moderate sedimentation was observed throughout.

Table 13: Site characteristics recorded within the assessed reach at LP-BS-DS.

LP-BS-DS: DOWNSTREAM SITE ON THE BRONKHORSTSPRUIT RIVER	
Upstream	**Downstream**
	

LP-BS-DS: DOWNSTREAM SITE ON THE BRONKHORSTSPRUIT RIVER	
Upstream	**Downstream**
Site Description	Situated approximately 2.5 km downstream of the LP-BS-US point at a point where a secondary tar road crossing the Bronkhorstspruit River. Evidence of cut-and-fill was recorded adjacent to the channel and a bridge structured associated with the aforementioned road had confined flow and caused ponding upstream and irregular through-flow
GPS Coordinates	Latitude: 26° 9'19.08"S Longitude: 28°42'9.36"E
Meters Above Sea Level (mamsl)	1551
Quaternary Catchment	B20A
Ecoregion (Level 1)	Highveld- Lower
Geomorphological Zonation	Lower Foothill
Channel type	3rd Order, 'C' Channel Stream (perennial) Primarily fed by attenuated stormwater from the Leeuwpan Colliery.
Channel Dimensions	Assessed Reach 70 m; Width 4 – 10 m; Depth 0.4-1.0 m
Water Turbidity	Medium
Water Flow Velocity	Low
Water Colour	Brown
% Algae and Other Litter	40 % algae, growth mostly noted on vegetation and stones, high abundance of plant matter on stream bed
Other Biota	None
Description of Disturbances	A bridge crossing and several upstream gravel roads were impeding and confining the flow. The road crossing was observed to have elevated the system base-level and consequently increased the velocity and erosion potential downslope. Areas of channel scouring in the form of deep pools, as well as bank slump were evident.

8 RESULTS

The field survey associated with this study took place on the 18th May 2020. This section provides the findings subsequent to the implementation of the various methodologies/tools utilised during this assessment.

8.1 Physicochemical Water Quality

On the day of the assessment a handheld calibrated device was utilised to take the major biota specific parameters listed in **Table 14**. This section will define the water quality measured on the day of the assessment according the Target Water Quality Ranges (TWQRs) for aquatic ecosystems set out by the DWS (1996) in order to establish the baseline water quality prior to the proposed development being constructed.

Table 14: *In situ* water quality of the samples collected during the 2019 and 2020 dry season field survey (Red indicates those readings outside of the relevant TWQR).

SAMPLE POINT	DRY SEASON	pH	CONDUCTIVITY mS/m	TDS (Mg/l)	DO (Mg/l)	DO (%)	TEMP. (ºC)
TWQR	YEAR	6.5-9.0	<70	<100 mg/l	>5.00	80-120	5-30
LP-BS-US (upstream)	2020	8.19	61.10	397.00	9.16	112.3	16.85
	2019	DRY/NO FLOW					
LP-BS-DS (downstream)	2020	8.39	62.90	408.00	6.26	71.60	13.90
	2019	9.46	45.40	295.00	6.41	75.40	14.90
LP-RK-US (upstream)	2020	7.54	47.00	305.00	7.45	92.80	17.73
	2019	DRY/NO FLOW					
LP-WEL-DS (downstream)	2020	7.10	53.80	349.00	6.31	70.20	12.65
	2019	9.88	45.50	297.00	4.17	49.30	14.93

pH

Fresh water aquatic systems are well buffered with a pH range from 6.5 to 8.5, most rivers are slightly alkaline due to bicarbonates and alkalis associated with earth metals (Barbour *et al.*, 1996). The TWQR for aquatic ecosystems is from 6.5-9.0 pH.

All four (4) biomonitoring points were recorded to present acceptable pH in without any exceedances of the TWQR during the 2020 dry season survey. However, it should be noted that LP-RK-US was sampled from pooling water that presented no flow. The overall improvement was presumably due to the increased rainfall prior to the site visit that likely resulted in the dilution of the water present in the system.

The results for the LP-BS-US and LP-BS-DS monitoring points indicate a basic pH environment associated with the Bronkhorstspruit River, which typically stems from an increased concentration of calcareous minerals resulting in carbonate buffering.

Electrical Conductivity (EC)

The Electrical Conductivity (EC) of a river is the ability of water to conduct an electrical current, this ability stems from the presence of carbonate, bicarbonate, chloride, sulphate, nitrate, sodium, potassium, calcium and magnesium ions present in the water (DWS, 1996). The TWQR for conductivity in freshwater systems is anything less than 70 mS/m. The EC readings were measured in µS/cm, where 1 microsiemens/centimetre [µS/cm] = 0.1 millisiemens/meter [mS/m].

The EC at all four (4) sites were recorded to have been within the TWQR for EC during the 2020 dry season field survey. Slightly higher EC readings were recorded at the downstream sites in comparison to their upstream counterparts. The Bronkhorstspruit River on which LKP-BS-US and LP-BS-DS was recorded to have overall higher EC readings than the other systems.

Total Dissolved Solids (TDS)

The amount of suspended material in the water column including anything from colloids (0.1 Femtometre (Fm)) to large organic and inorganic materials is known as Total Dissolved Solids (TDS) of a river. The increase of suspended solids occurs with discharge of sediment during rainfall, as the flow returns to normal and the solids remain suspended in the water column. This parameter must be monitored closely in correlation with the EC reading captured at each point, as there is a strong correlation between the conductivity and the cations and anions that are typically contained in the TDS within a system. The TWQR for aquatic systems is anything less than 100 mg/l (DWS, 1996). Prolonged exposure may have an effect on the nutrient cycling of sensitive taxa within the reach (DWS, 1996).

Water samples from all four (4) biomonitoring sites were recorded to contain TDS concentrations that exceeded the TWQR for TDS. The LP-BS-US, LP-BS-DS, LP-RK-US and LP-WEL-DS sites contained 75 %, 75 %, 67 % and 71 % more TDS than the max TWQR for TDS. The increased TDS is likely associated with the recent input of sediment due to rainfall prior to the assessment.

Dissolved Oxygen (DO)

The Dissolved Oxygen (DO) present in the water column originates from the atmosphere via rainfall, turbid water in fast flowing streams and is a product of photosynthesis by hydrophilic floral species, specifically microalgae. As a result of all aerobic organisms needing oxygen to survive, DO is considered an accurate measure of the health of an aquatic ecosystem. In moderate-to-large sized dams the levels of DO may rise during the day as a result of photosynthesis, but may reduce during the night to plant respiration.

Additionally, the excessive presence of IAPS, algae and aerobic bacteria will reduce the amount of DO in the water column as a result of their exorbitant uptake in eutrophic conditions, which are a consequence of mining and sewage effluent and agricultural chemical runoff enriching the water and stimulating the growth of the aforementioned organisms.

The optimum DO level for fish species and macroinvertebrates, such as mayflies, stonefly larvae and caddisflies, to thrive in is >5 mg/l, or between 80 and 120%. When aerobic organisms are exposed to DO concentrations lower than 2 mg/l serious fish deaths may occur over a medium-to-long term period (DWS, 1996). It is evident from **Table 14** that the water columns at both downstream biomonitoring points (LP-BS-DS and LP-WEL-DS) were recorded to contained DO (%) that fell outside of the TWQR for the relevant parameters. The high levels of nutrients entering into the watercourses from the agricultural activities within the upstream catchment may have influenced the DO content within the water column, because typically the more nutrients that are within a system the more eutrophic the conditions are. Additionally, increased algal proliferation noted at these monitoring points is likely the cause for the decreased DO readings measured. This parameter must thus be strictly monitored and the sediment/effluent/sludge originating from the site managed to ensure that no excess chemical constituents get the opportunity to flow or seep into the downstream watercourses.

8.2 Toxicity Testing

To better understand and quantify the potential impact of the Leeuwpan Colliery on the downstream aquatic ecosystems, an acute and short-chronic toxicity test was conducted on water samples collected from the four (4) biomonitoring sites that are situated within the colliery.

To aid in the interpretation of **Table 16 and 17** below, please refer to **Table 15** which presents the classification of the overall hazard classes based on the DEEEP protocol. A risk/hazard category was determined by application of the DEEEP DWA recommended protocols and is broadly based on the hazard classification system of Persoone et al. (2003). This risk category equates to the level of acute/chronic risk posed by the selected potential pollution source (water sample). After the determination of the percentage effect (EP), obtained with each of the battery of toxicity tests performed, the sample is ranked into one of the following five classes, based on screening testing protocols.

Table 15: Presentation of the overall hazard classed based on the DEEEP protocol.

CLASSES	DESCRIPTION
CLASS I	**No acute/short-chronic environmental toxicity hazard -** none of the tests shows a toxic effect (i.e. an effect value significantly higher than that in the control)
CLASS II	**Slight acute/short-chronic environmental toxicity hazard -** a statistically significant (P<0,05) percentage effect is reached in at least one test, but the effect level is below 50%
CLASS III	**Acute/short-chronic environmental toxicity hazard -** the percentage effect level is reached or exceeded in at least one test, but the effect level is 50-99%

CLASSES	DESCRIPTION
CLASS IV	**High acute/short-chronic environmental toxicity hazard -** the 100% percentage effect is reached in at least one test
CLASS V	**Very high acute/short-chronic environmental toxicity hazard -** the 100% percentage effect is reached in all the tests

The results depicted in **Table 16** present a Class II (Slight acute/short-chronic environmental toxicity hazard) hazard for the P. reticulata (Guppy) test organism at LP-BS-DS. As the corresponding upstream monitoring sites associated with LP-BS-DS presented no hazard, there was influence on the downstream site from the Leeuwpan Colliery and surrounding agricultural lands. Direct input into the downstream LP-BS-DS site from the Leeuwpan Colliery was recorded at an outlet situated at 26° 09' 58.24" S, 28° 42' 21.73" E, as well as from subsurface seepage that is evident directly east of this position. There was however also presumed influence from the adjacent agricultural lands, and stormwater runoff from the tar road that traversed the system on which the LP-BS-DS site is situated. Although this was the case, the quantity of flow entering the downstream system from the Leeuwpan site is assumed to have been higher than from the other land-uses and therefore it can be stated that the activities that were being conducted at the Leeuwpan Colliery during the 2020 dry season field survey were having a slight negative impact on the downstream Bronkhorstspruit River. Specifically, the fish population within the system.

Table 16: Acute Toxicity Analysis of the water samples that were collected at the relevant biomonitoring sites.

Test spp.	Results	LP-WEL-DS	LP-BS-DS	LP-BS-US	LP-RK-US
A. fischeri (Bacteria)	%30min inhibition (-) / stimulation (+) (%)	18	7	7	-2
	EC/LC20 (30 mins)	*	*	*	*
	EC/LC50 (30 mins)	*	*	*	*
	Toxicity unit (TU) / Description	No short-chronic hazard	No short-chronic hazard	No short-chronic hazard	No short-chronic hazard
S. capricornutum (micro-algae)	%48hr mortality rate (-%)	-7	-4	-7	-8
	EC/LC10 (48hrs)	*	*	*	*
	EC/LC50 (48hrs)	*	*	*	*
	Toxicity Unit (TU)	No short-chronic hazard	No short-chronic hazard	No short-chronic hazard	No short-chronic hazard
D. magna (Water Flea)	%48hour mortality rate (-%)	0	0	0	0
	EC/LC10 (48hours)	*	*	*	*
	EC/LC50 (48hours)	*	*	*	*

Test spp.	Results	LP-WEL-DS	LP-BS-DS	LP-BS-US	LP-RK-US
	Toxicity unit (TU) / Description	No acute hazard	No acute hazard	No acute hazard	No acute hazard
***P. reticulata* (Guppy)**	%96% mortality rate (-%)	-8	-17	0	0
	EC/LC10 (96hrs)	*	*	*	*
	EC/LC50 (96hrs)	*	*	*	*
	Toxicity unit (TU) / Description	No acute hazard	**S.D.O.T.H**	No acute hazard	No acute hazard
Overall classification - Hazard class* **		Class I- No acute/short-chronic hazard	Class II- Slight acute hazard	Class I- No acute/short-chronic hazard	Class I- No acute/short-chronic hazard
Weight (%)		0	25	0	0

KEY:

* = EC/LC values not determined, definitive testing required if a hazard was observed and persists over subsequent sampling runs;

*** = The overall hazard classification takes into account the full battery of tests and is not based on a single test result. Note that the overall hazard classification is expressed as acute/short-chronic level of toxicity, due to the fact that the *S. capricornutum* (micro-algae) and the *A. fischeri* tests are regarded as short-chronic levels of toxicity tests and the overall classification therefore contains a degree of short-chronic toxicity assessment.

S.D.O.T.H = Some degree of acute/short-chronic toxic hazard based on this single test organism, refer to overall hazard classification, which takes into account the full battery of test organisms.

Weight (%) = Relative toxicity levels (out of 100%), higher values indicate that more of the individual tests indicated toxicity within a specific class

Table 17 below presents the toxicity results obtained at three (3) sites within the Leeuwpan Colliery boundary during Quarters 1 and 2 of 2020. These sites were analysed to determine whether the water situated within the site may pose a risk if entering the downstream watercourses. It must however be noted that these sample sites are situated in the central and northern regions of the site, and not within the western portion close to the tributary of the Bronkhorstspruit River. None of the tests conducted on samples collected from these sites during Q1 and Q2 of 2020 were determined to pose environmental hazard to the two trophic levels that were tested for.

Table 17: Acute Toxicity Analysis of the additional water samples that were collected at the relevant sites.

Test spp.	Results	Q1: March 2020			Q2: May 2020		
		KR01A	D-DS/ LSW13	LSW 09	KR01A	D-DS/ LSW13	LSW 09
A. fischeri (Bacteria)	%30min inhibition (-) / stimulation (+) (%)	81	41	73	162	69	51
	EC/LC20 (30 mins)	*	*	*	*	*	*
	EC/LC50 (30 mins)	*	*	*	*	*	*
	Toxicity unit (TU) / Description	No short-chronic hazard	No short-chronic hazard	No short-chronic hazard	No short-chronic hazard	No short-chronic hazard	No short-chronic hazard
D. magna (Water Flea)	%48hour mortality rate (-%)	0	0	0	0	0	0
	EC/LC10 (48hours)	*	*	*	*	*	*
	EC/LC50 (48hours)	*	*	*	*	*	*
	Toxicity unit (TU) / Description	No acute hazard	No acute hazard	No acute hazard	No acute hazard	No acute hazard	No acute hazard
Overall classification - Hazard class* **		Class I- No acute/short-chronic hazard	Class I- No acute/short-chronic hazard	Class I- No acute/short-chronic hazard	Class I- No acute/short-chronic hazard	Class I- No acute/short-chronic hazard	Class I- No acute/short-chronic hazard
Weight (%)		0	0	0	0	0	0

KEY:

* = EC/LC values not determined, definitive testing required if a hazard was observed and persists over subsequent sampling runs;

*** = The overall hazard classification normally takes into account the full battery (at least 3) of tests and is not based on a single test result. In this case ENVASS requested only 2 trophic levels - note that the overall hazard classification is expressed as acute (*Daphnia*) and short-chronic (*Aliivibrio*) with one representative trophic level for each level of testing only.

Weight (%) = Relative toxicity levels (out of 100%), higher values indicate that more of the individual tests indicated toxicity within a specific class.

8.3 Diatom Analysis

A diatom assessment was conducted by Ecotone Freshwater Consultants (May 2020) for the four (4) possible sites during the 2020 dry season assessment. The diatom assessment is divided into three sub-sections: (i) Discusses the ecological classification of water quality for each site according to the diatom assemblage during this assessment. (ii) Provides analyses and discussion of the dominant species and their ecological preference at each site. Thus, allowing spatial variation analyses of ecological water quality between sites. The following was extracted from the Ecotone (May 2020) report. The full report can be made available on request.

8.3.1 Ecological Classification

The ecological classification for water quality according to Van Dam *et al.* (1994) and Taylor *et al*. (2007), includes the preferences of freshwater and brackish water diatom species in terms of pH, nitrogen, oxygen, salinity, pollution levels and trophic state as provided by OMNIDIA (Le Cointe *et al*., 1993). The overall diatom assemblages at the four (4) sampled sites comprised of species with a preference for (**Table 18**):

- Fresh brackish (<500 µS/cm), circumneutral (pH 6.5- 7.5) to alkaline (pH > 7) waters and indifferent to eutrophic conditions;
- The nitrogen requirements for all sites were N-Autotrophic tolerant, indicating a tolerance for elevated concentrations of organically bound nitrogen;
- The dissolved oxygen saturation requirements ranged from low (<30%) to very high (~100%) for all sites;
- The pollution level indicated that there was some form of pollution present at all sites (β-mesosaprobic – slightly polluted to α-meso-polysaprobic- polluted waters).

Table 18: Ecological descriptions of the four (4) sites at the Leeuwpan Colliery based on the diatom community (van Dam *et al*., 1994; Taylor *et al*., 2007).

SITE	PH	SALINITY	ORGANIC NITROGEN UPTAKE	OXYGEN LEVELS	POLLUTION LEVELS	TROPHIC STATE
LP-RK-US	Circumneutral	Fresh brackish	N-Heterotrophic facultative	Low	α-meso-polysaprobic	Eutrophic
LP-WEL-DS	Alkaline	Fresh brackish	N-Heterotrophic facultative	Moderate	α-mesosaprobic	Eutrophic
LS-BS-US	Circumneutral	Fresh brackish	N-Autotrophic tolerant	High	β-mesosaprobic	Indifferent
LS-BS-DS	Alkaline	Fresh brackish	N-Autotrophic tolerant	Low	α-meso-polysaprobic	Eutrophic

KEY: Eutrophic- High primary productivity, rich in mineral nutrients required by plants, β- mesosaprobic- Moderately polluted (O_2 deficit <30%), α-meso-polysaprobic- Heavily polluted (O_2 deficit between <75% and <90%), α-mesosaprobic- Critically polluted (O_2 deficit <50%).

8.3.2 Diatom Spatial Analysis

A total of 38 diatom species were recorded at the four (4) sites and the dominant species recorded included *Nitzschia sp., Gomphonema sp. and Ulnaria ulna.* These species are cosmopolitan in nature and have wide ecological amplitudes. Thus, caution must be taken when analysing the predominance of these species at specific sites and it is important to consider these dominant species in conjunction with the entire diatom assemblage when analysing the results. Ecological information is provided below for the dominant and sub-dominant species in order to make ecological inferences for the four (4) sites as noted in **Table 19** (Taylor et al., 2007, Cantonati et al., 2017):

Site LP-RK-US: The dominance of *G. parvulum* and *Gomphonema sp.* pointed to oligo-to mesosaprobic conditions, and this taxon is often associated with water that has been impacted by agricultural run-off. The subdominance of *N. palea* pointed to electrolyte-rich habitats with organic enrichment and polluted running waters. The subdominance of *G. angustum* pointed to strongly calcium-rich freshwater habitats. The presence of *Sellaphora pupula* pointed to alkaline, eutrophic flowing waters with moderate levels of electrolyte content. The presence of *Diadesmis confervacea* pointed to water that is usually contaminated with organic matter. The diatom community results indicated that the ecological water quality at this site reflected electrolyte-rich habitats with organic enrichment and polluted running waters. This site appeared to have high levels of organic pollution present as evident by the very high %PTV score. The overall ecological water quality at this site was considered Poor.

Site LP-WEL-DS: The dominance of *Melosira varians* pointed to moderate electrolyte-rich, eutrophic running water. The subdominance of *U. ulna* pointed to slightly alkaline, medium conductivity, oligosaprobic, eutrophic habitats. The presence of *Nitzschia sp., N. intermedia*, and *N. palea* pointed to electrolyte-rich habitats with organic enrichment and polluted running waters and taxa within this genus are often tolerant of polluted conditions. The presence of *Planothidium frequentissimum* pointed to mesotrophic running waters with moderate electrolyte content and this taxon is tolerant to polluted conditions. The presence of *G. parvulum* pointed to oligo-to mesosaprobic, but oligo- to eutrophic freshwater habitats with medium electrolyte content. The presence of *Navicula sp.* pointed to brackish conditions and eutrophic running water and taxa within this genus are commonly found in organically polluted water. The diatom community results indicated that the ecological water quality at this site reflected moderate electrolyte content and appeared to be slightly disturbed by organic inputs. The %PTV score indicated that there was evidence of moderate levels of organic pollution present at this site. The overall ecological water quality at this site was considered Poor.

Site LP-BS-US: The dominance of *A. minutissimum* pointed to oligosaprobic, oligo- to eutrophic, weakly-alkaline, freshwater habitats with moderately high electrolyte content. The subdominance of *U. ulna* pointed to slightly alkaline, medium conductivity, oligosaprobic, eutrophic habitats. The presence of *Navicula sp.* pointed to brackish conditions and eutrophic

running water and taxa within the genus *Navicula* are commonly found in organically polluted water. The presence of *Nitzschia sp*. and *N. palea* pointed to electrolyte-rich habitats with organic enrichment and polluted running waters. The presence of *G. parvulum* pointed to mesosaprobic conditions, and this taxon is often associated with water that has been impacted by agricultural run-off. The diatom community results indicated that the ecological water quality at this site appeared to be disturbed by high-electrolyte content and organic inputs. The %PTV score indicated that there was evidence of moderate levels of organic pollution present at this site. The overall ecological water quality at this site was considered Poor.

Site LP-BS-DS: The dominance of *Amphora sp.* pointed to oligo-to eutrophic freshwater habitats with medium to high electrolyte content. The subdominance of *U. ulna* pointed to slightly alkaline, medium conductivity, oligosaprobic, eutrophic habitats. The subdominance of *N. palea* pointed to electrolyte-rich habitats with organic enrichment and polluted running waters. The presence of *G. parvulum* and *Gomphonema sp.* pointed to mesosaprobic conditions, and this taxon is often associated with water that has been impacted by agricultural run-off. The presence of *Navicula sp*. pointed to brackish conditions and eutrophic running water as taxa within this genus are commonly found in organically polluted water. The diatom community results indicated that the ecological water quality at this site was disturbed by moderate electrolyte content and organic inputs. The %PTV score indicated that there was evidence of moderate levels of organic pollution present at this site. The overall ecological water quality at this site was considered Poor

The Specific Pollution Sensitivity Index (SPI) was used in this diatom assessment and is an inclusive index and takes factors such as salinity, eutrophication and organic pollution into account (Cemagref, 1982). The SPI index is based on a score between 0 – 20, where a score of 20 indicates no pollution and a score of zero indicates an increasing level of pollution or eutrophication. The Percentage Pollution Tolerant Value (%PTV) is part of the UK Trophic Diatom Index (TDI) (Kelly & Whitton, 1995) and was developed for monitoring organic pollution (sewage outfall- orthophosphate-phosphorus concentrations), and not general stream quality. The %PTV has a maximum score of 100, where a score above 0 indicates no organic pollution and a score of 100 indicates definite and severe organic pollution. The presence of more than 20% PTVs shows organic impact. All calculations were computed using OMNIDIA ver. 4.2 program (Lecointe *et al*., 1993).

Table 19 below presents the relevant SPI and %PTV values, as well as the overall ecological category and class per site.

According to the diatom community the ecological water quality showed very little spatial variation between sites. Sites LP_RK_US and LP_WEL_DS appeared to have been disturbed by high electrolyte contents and organic inputs and reflected Poor conditions. However, the upstream site (LP_RK_US) appeared to be disturbed to a greater extent, reflecting higher levels of organic pollution compared to the downstream site (LP_WEL_DS). Although the downstream site appeared to be slightly less disturbed, the level of organic pollution was moderate suggesting that some other form of pollution may also be contributing to the disturbance.

Sites LP_BS_US and LP_BS_DS appeared to be disturbed by organic inputs and reflected Poor ecological water quality. However, the upstream site (LP_BS_UP) appeared to be slightly less impacted reflecting lower levels of organic pollution compared to the downstream site (LP_BS_DS) which reflected high levels of organic pollution. Owing to the moderate level of organic pollution at the upstream site, it is possible that some other form of pollution may be contributing to the observed disturbance. The disturbances reflected at these sites may be associated with runoff from the surrounding landscape or from anthropogenic inputs into the system; however, it is difficult to distinguish between the impacts.

Table 19: Diatom index scores for the study sites that had sufficient diatom counts to determine the ecological condition of the water column.

SITE	%PTV	SPI	ECOLOGICAL CATEGORY (EC)	CLASS
LP-RK-US	58.6	6.1	**D/E**	Poor
LP-WEL-DS	13.6	9.3	**D**	Poor
LP-BS-US	16.2	9.5	**D**	Poor
LP-BS-DS	24.0	8.5	**D**	Poor

The diatom assemblages were generally comprised of species characteristic of fresh brackish, circumneutral to alkaline waters and indifferent to eutrophic conditions. The pollution levels indicated that there was some form of pollution evident at all the sites. According to the diatom community the ecological water quality showed very little spatial variation between sites. Sites LP-RK-US and LP-WEL-DS appeared to be disturbed by high electrolyte contents and organic inputs and reflected *Poor* conditions. Sites LP-BS-US and LP-BS-DS appeared to be disturbed by organic inputs and reflected *Poor* ecological water quality. The disturbances reflected at these sites may be associated with runoff from the surrounding landscape or from anthropogenic inputs into the system; however, it is difficult to distinguish between the impacts. According to the temporal diatom analysis trends site LP-WEL-DS showed an overall decline in the ecological water quality from *Moderate* to *Poor,* but the level of organic pollution remained moderate. Whereas, site LP-BS-DS showed a slight improvement in the ecological water quality but also showed a stable trend in the level of organic pollution.

8.4 Integrated Habitat Assessment System (IHAS)

The Integrated Habitat Assessment Systems (IHAS) is used in conjunction with the SASS5 methodology to establish if low SASS scores may be responsible to limited habitat availability, or alternately modified water quality (**Table 20**).

Table 20: The Integrated Habitat Assessment System (IHAS) scores for the Leeuwpan Colliery biomonitoring sites during the 2019 and 2020 field survey.

BIOMONITORING POINT	DRY SEASON	IHAS SCORE	CATEGORY	CHARACTERISTICS
LP-BS-US (Upstream)	**2020**	57 %	**Inadequate:** Habitat insufficient for supporting a diverse macroinvertebrate community.	• Dominating habitat was GSM which consisted predominantly of mud. • Few stones, with 60 % covered in Algae. • Water was damming downstream before the bridge with low flow upstream and downstream thereof. • Vegetation was moderately divers with an abundance of grass on the stream bed.
	2019	**DRY/NO FLOW**		
LP-BS-DS (Downstream)	**2020**	48 %	**Inadequate:** Habitat insufficient for supporting a diverse macroinvertebrate community.	• Little to no Stones (S) biotope was available for sampling. A stretch of approximately 1 m was sampled. • Deep pools in two areas upstream and downstream of a bridge structure were sampleable. • Riparian vegetation was absent, however fringe vegetation included sedges and grass species. • Reach was dominated by GSM, with sand being the most prominent aspect.
	2019	44 %	**Inadequate:** Habitat insufficient for supporting a diverse macroinvertebrate community.	
LP-RK-US (Upstream)	**2020**	**STAGNANT POOL/NO FLOW**		
	2019	**DRY/NO FLOW**		

BIOMONITORING POINT	DRY SEASON	IHAS SCORE	CATEGORY	CHARACTERISTICS
LP-WEL-DS (Downstream)	**2020**	59 %	**Inadequate:** Habitat insufficient for supporting a diverse macroinvertebrate community.	• A single run of approximately 4 m comprised of stones of between 2 and 10 cm was sampled. • A deep pool with a sand/gravel substrate with intermittent stones was sampled. • Algae was present on most stones and on the surface of the water. • Vegetation was limited to sedges and reeds with grass species not interacting with the water body.
	2019	52 %	**Inadequate:** Habitat insufficient for supporting a diverse macroinvertebrate community.	

8.5 South African Scoring System 5 (SASS5) Data Interpretation

Out of the four (4) predetermined biomonitoring sites, only three (3) were sampleable and the results analysed during the 2020 dry season field survey (**Table 21**). During the field survey, between 17 and 22 taxa were identified at each site associated within the assessed reaches. There were no RHP reference sites situated in any of the B20A quaternary catchment areas, and thus the SASS5 interpretation guidelines constituted as the only 'natural' sites to compare the overall results against.

The following observations were made when comparing the 2020 dry season data to the information that was recorded from the previous 2019 dry season survey:

- **LP-BS-US**: No change could be determined between 2019 and 2020, as this site was dry in 2019. However, when compared to the 2018 dry season result the SASS Score and number of taxa were recorded to be 18 % and 29 % higher (better) in 2020 than in 2018, respectively. This resulted in the ecological category improving from a Class D (Near natural) in 2018 to a Class C (Moderately modified) in 2020.
- **LP-BS-DS**: When comparing the 2020 results to those obtained in 2019, the SASS Score and number of taxa were recorded to have been 46 % and 45 % higher (better) in 2020 than in 2019, respectively. This resulted in the ecological category improving from a Class E/F (Seriously Modified) to a Class B (Near natural) in 2020.
- **LP-RK-US**: No change could be determined as this site was dry in 2019 and only a small stagnant pool was noted in 2020.

- **LP-WEL-DS**: The SASS Score and number of taxa were recorded to be 15 % and 16 % higher (better) in 2020 than in 2019, respectively. This resulted in the ecological category improving from a Class C (Moderately modified) to Class B (Near natural) in 2020.

The following will compare the upstream scoring to those obtained at the corresponding downstream sites:

- LP-BS-US to LP-BS-DS: The ASPT at the upstream point (LP-BS-US) was 13 % lower (worse) than in 2018 (dry in 2019), however the Ecological category improved unto a class C due to the increase of taxa that is likely due to a reduction of pollution and increased flow recorded at this point. This was furthermore reflected by the improvement recorded at the downstream point (LP-DS-DS) that recorded a major improvement in ecological category (from E/F unto B) and slight improvement in ASPT. This overall improvement is likely due to increased input of clean water into the system prior to sampling resulting in the improved conditions and habitat availability.
- LP-RK-US to LP-WEL-DS: The upstream tributary point (LP-RK-US) indicated stagnant conditions and could not be assessed using SASS5 methodologies. However, the improvement unto a class B ecological state was noted at the downstream (LP-WEL-DS) point. Since the SASS score and number of Taxa was higher in comparison to the previous monitoring period and the ASPT remained the same, it can be concluded that the increased flow resulted in higher habitat availability for tolerable species but the absence of sensitive species reveals that water quality remains impacted.

In comparison these findings reveal that an increased in pollution tolerant species were present, likely due to the reduction in water quality and increased quantity during the assessment period when comparing results from the upstream to downstream environments. This statement is made due to the increased amounts of taxa and decreased or similar ASPT values as described above.

Table 21: SASS5 results collected and analysed for the sites associated with the Leeuwpan Colliery.

SAMPLE POINT	SEASON	NO. OF TAXA	% CHANGE SINCE LAST PERIOD	SASS5 SCORE	% CHANGE SINCE LAST PERIOD	ASPT	% CHANGE SINCE LAST PERIOD	ECOLOGICAL CATEGORY
LEEUWPAN COLLIERY								
LP-BS-US (Upstream)	DRY 2020	17	29↑	66	18↑	3.9	13↓	C
	DRY 2019	DRY/NO FLOW						

SAMPLE POINT	SEASON	NO. OF TAXA	% CHANGE SINCE LAST PERIOD	SASS5 SCORE	% CHANGE SINCE LAST PERIOD	ASPT	% CHANGE SINCE LAST PERIOD	ECOLOGICAL CATEGORY
	DRY 2018	12	**N/A**	54	**N/A**	4.5	**N/A**	**D**
LP-BS-DS (Downstream)	**DRY 2020**	**22**	**45 ↑**	**85**	**46 ↑**	**3.9**	**3 ↑**	**B**
	DRY 2019	12		46		3.8		**E/F**
	DRY 2018	12		46		3.8		**E/F**
LP-RK-US (Upstream)	**DRY 2020**	**STAGNANT**						
	DRY 2019	**DRY/NO FLOW**						
	DRY 2018	15	**N/A**	60	**N/A**	4.00	**N/A**	**D**
LP-WEL-DS (Downstream)	**DRY 2020**	**19**	**16 % ↑**	**87**	**15 % ↑**	**4.6**	**0 %**	**B**
	DRY 2019	16		74		4.6		**C**
	DRY 2018	20		100		5.0		**B**

KEY: ↑ - Increased since last monitoring period.

Figure 13 below illustrates the ecological categories that were calculated for the biomonitoring sites associated with the Leeuwpan Colliery utilising the Highveld- Lower ecoregion bilogical bands, which were interpreted using the Dallas (2007) percentiles.

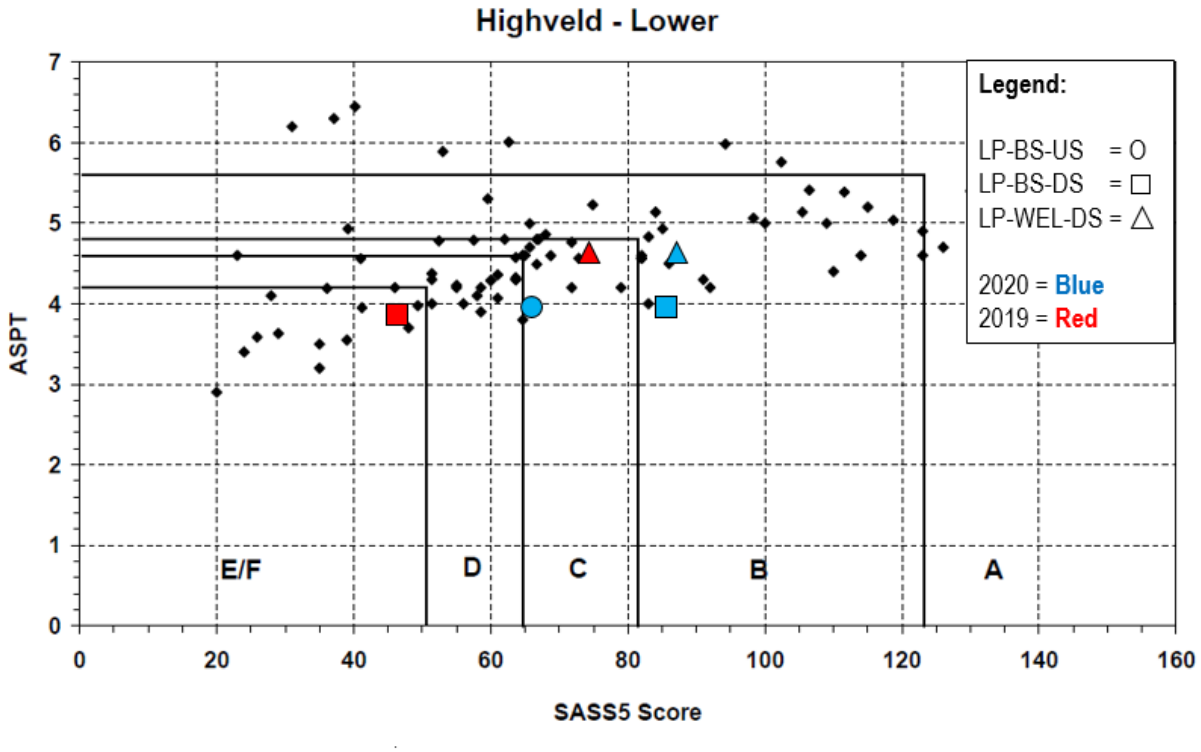


Figure 13: Illustration of the SASS interpretation guideline relevant to the Highveld- Lower ecoregion (Dallas, 2007).

9 CONCLUSION AND SPECIALIST'S RECOMMENDATION

It is evident that the aquatic systems in the vicinity of the existing licensed Leeuwpan Colliery have been moderately disturbed and thus degraded by the current and historical land-uses, specifically agriculture, within the catchment area. Based on the toxicity testing and diatom assessment that were conducted for the 2020 dry season survey, it is the specialists substantive opinion that the Leeuwpan Colliery was having having a slight negative impact on the downstream aquatic ecosystems at LP-BS-DS and LP-WEL-DS. However, based on the water quality, IHAS and SASS5 analysis this impact can be mitigated by following protocol throughout the production process onsite, adhering to the limits stipulated within the WUL (Ref no. 04/B20A/CIJ/4032) and implementing the recommendation stipulated below. The attributes that influenced this conclusion included the following:

- Slight decrease in overall water quality from upstream sites LP-BS-US to LP-BS-DS and from LP-RK-US to LP-WEL-DS. This trend was mirrored in the diatom assessment, which highlighted more eutrophic and higher pollution levels at the LP-BS-DS site than the upstream LP-BS-US site. Adversely, more organic pollution was recorded at the upstream LP-RK-US site than at the corresponding downstream LP-WEL-DS site, but both samples indicated eutrophic conditions.
- The upstream site (LP-BS-US) was determined to pose no acute or short-chronic environmental hazard, however the downstream site (LP-BS-DS) was determined to be of a slight environmental toxicity hazard presented by a Direct Estimate of Ecological Effect Potential (DEEEP) Class II. Subsurface seepage from a historic farm dam situated within the Leeuwpan Colliery at 26° 10' 00.22" S, 28° 42' 41.98" E was observed to be flowing into the

downstream tributary of the Bronkhorstspuit River above site LP-BS-DS. There may therefore be an influence from this farm dam on the change in toxicity levels evident at LP-BS-DS. Surrounding land-uses were also considered, however as a higher flow volume was entering the system from farm dam than the agricultural croplands and stormwater runoff from the adjacent tar road, it was determined to have a higher influence on this conclusion.

- The previously elevated pH has decreased unto overall acceptable levels, likely the result of dilution due to increased rainfall in the area prior to the assessment. This was mirrored by both sites having improved and only LP-WEL-DS being determined to fall within Class II (Slight environmental toxicity hazard) toxicity, LP-WEL-DS recording Some Degree of Acute/Short- chronic Toxic Hazard (S.D.O.T.H) at one (1) trophic level.
- The diatom analysis recorded eutrophic conditions at LP-WEL-DS and the conclusion was that the habitat decreased and impacted water quality was evident. The diatom analysis on the downstream point LP-BS-DS also indicated slightly impacted water quality, however this impact was largely present in the upstream environment at LP-BS-US as well. However, since the on-site sampled revealed no acute toxicity it cannot be conclusively stated that the pollution is attributed to the site. These results revealed that surrounding activities in the upstream environment had a definitive impact and only a slight decrease was observed at the downstream point.
- The overall increase in aquatic macroinvertebrate health at the downstream biomonitoring sites was presumably due to the dilution of water attributed to the elevated availability of water at the monitoring points and the overall increased water quality measured and therewith the slightly improved habitat.

Specialist's Recommendation

- The banks of the artificial earthen channels that have been excavated to divert flow around the mining areas should be landscaped to slopes exhibiting a ratio of 1:3 (v:h) and revegetation with plugs from the surrounding wetland area. This will provide further filtration of the stormwater runoff and episodic flow through the channels and into the downstream Bronkhorstspruit River. Ideally, the existing wetlands on-site should be maintained at their base-line Present Ecological State score (PRES) by implementing rehabilitation and mitigation measures. This will increase the filtration of potentially harmful contaminants that may be present in the surface- and subsurface-flow that may be originating from the Leeuwpan Colliery.
- Toxicity testing of the water within the historic farm dam at 26° 10' 00.22" S, 28° 42' 41.98" E should be considered. This may further narrow the search for any potential contamination sources on-site and create further measures of monitoring the potential impact on water quality within the downstream aquatic ecosystems.
- Clearing of Invasive Alien Plant Species (IAPS) from the aquatic ecosystems in areas under the control of the mine and associated with the reaches on which the affected biomonitoring points are situated to improve the water balance and natural biodiversity within and around the system. The controlling and maintenance of all IAPS on a land owner portion is a legal requirement in terms of the National Environmental Management: Biodiversity Act (Act no. 10 of 2004) Alien and Invasive Species List, 2016 (DEA, 2016).
- Ongoing monitoring of the aquatic community integrity, that is implemented at the Leeuwpan Colliery, should be maintained.
- The results presented within this biannual 2020 dry season aquatic assessment of the biomonitoring points associated with the Leeuwpan Colliery must be spatially and temporally compared to the results obtained during previous and future dry season biomonitoring studies. If the comparison highlights any significant alteration in the health/integrity of the at-risk or downstream aquatic ecosystems, the cause, extent and significance of the impact must be identified and appropriate mitigation and/or rehabilitation measures implemented to improve the health of the impacted systems.

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11 APPENDIX A: SPECIALIST'S QUALIFICATIONS

EMPLOYEE NAME **WIETSCHE ROETS**

POSITION **ENVIRONMENTAL DATA ANALYST AND CONSULTANT**

DETAILS
Office: 394 Tram Street, New Muckleneuk, Pretoria, 0181
T: 012 460 9768; M: 072 316 6512; F: 012 460 9768
E mail: roets@envass.co.za

EDUCATION AND QUALIFICATIONS

Completed	Qualification
2015	**BSc Honours in Environmental Sciences** North-West University (NWU), Potchefstroom.
2014	**BSc in Environmental and Biological Sciences** North-West University (NWU), Potchefstroom.
2011	**Matriculation** High School Outeniqua, George

PROFESSIONAL AFFILIATIONS

Registered as a Candidate Scientist with the South African Council of Natural Scientific Professionals (SACNASP) (no. 119357).

EXPERIENCE

Environmental Assurance (Pty) Ltd. (ENVASS) - Day to day work and monthly field assessments of water and air quality, data capturing, data interpretation and recommendations. Site assessments and inspections. GIS mapping and updates. Report writing with recommendations and client interaction. DWS SASS5 Accredited Practitioner. Specialist studies in relation to Noise, Invasive Alien Plant Species Control Plans and Biomonitoring.

Employer **Environmental Assurance (Pty) Ltd. (ENVASS)**

Period April 2017 – Current

Position **Environmental Data Analyst and Consultant**

Responsibilities Data capturing, processing and interpretation. Proposal composition, marketing, fieldwork and report planning, client liaison, Noise Assessments, Invasive Alien Plant Assessments, Aquatic Biomonitoring.

INTERNAL & EXTERNAL COURSES

2020	**Back-2-Basics Wetland Workshop** GDARD, Rietvlei Nature Reserve.
2019	**SASS5 Accreditation** Department of Water and Sanitation (DWS)
2019	**Environmental Legal Update Training** TABACKS C&A Law Advisors

2018 **SASS5 Aquatic Biomonitoring Training**
GroundTruth

2018 **Basic Life Support and First Aid Procedures (Level 1)**
NOSA Training Centre, Centurion.

2017 **Environmental Legal Update Training**
MacRobert Attorneys

2017 **Higher Certificate in Christian Life (HCCL)**
South African Theological Seminary (SATS)

REFERENCES

CONTACT NAME	COMPANY	RELATIONSHIP	CONTACT NR
Prof. Victor Wepener	NWU Potchefstroom	Professor	018 299 2385
Mr. Carl Schoeman	ENVASS	Co-worker	071 371 1178
Dr. Wietsche Roets	DWS	Father	082 604 7730

SACNASP

South African Council for Natural Scientific Professions

herewith certifies that

Wietsche Roets

Registration Number: 119357

is a registered scientist

in terms of section 20(3) of the Natural Scientific Professions Act, 2003
(Act 27 of 2003)
in the following fields(s) of practice (Schedule 1 of the Act)

Environmental Science (Candidate Natural Scientist)

Effective **6 June 2018** Expires **31 March 2021**

Chairperson

Chief Executive Officer

To verify this certificate scan this code

NATIONAL AQUATIC ECOSYSTEM HEALTH MONITORING PROGRAMME

Water and Sanitation
Environment Affairs

Water Research Commission

CERTIFICATE OF ACCREDITATION

This is to certify that

Wietsche Roets Jr.

has met the requirements of the
River Health Programme as a SASS5 Practitioner



COMPETENCY IN THE FOLLOWING AREAS HAVE BEEN DEMONSTRATED:

UNDERSTANDING OF THE SCOPE AND APPLICATION OF THE SASS5 METHOD.
DEMONSTRATION OF THE CORRECT SAMPLING PROTOCOLS
DEMONSTRATION OF THE CORRECT SAMPLE PREPARATION PROTOCOLS
IDENTIFICATION OF AQUATIC MACROINVERTEBRATES

COMPETENCY IS VALID FOR 3 YEARS FROM CERTIFICATE DATE

NATIONAL SASS5 AUDITOR

19 July 2019
DATE

CERTIFICATION

I, **WIETSCHE ROETS**

Declare that, to the best of my knowledge, all the information contained herein is true.

Signature: 

On the 2nd day of July 2020

Annexure E
Water Balance



Integrated Water Balance Report for

LEEUWPAN MINE

Exxaro Resources Ltd

October 2020



Prepared by:

Charles Linström
Hydrologist Pr.Sci.Nat.
Sustainability

Tel + 27 12 307 4100
Mobile + 27 83 609 0173
Email charles.linstrom@exxaro.com
www.exxaro.com

exxaro
POWERING POSSIBILITY

1. INTRODUCTION

Leeuwpan mine is situated 80km south-east from Pretoria and close to the town of Delmas in the Mpumalanga Province. The mine employs about 490 people. Leeuwpan is an open-pit mine producing 6.7 Mtpa ROM of metallurgical and power station coal. This conventional open-pit mine uses modified terraced configurations and truck and shovel methods. The coal is processed using jigging technology and dense medium separation.

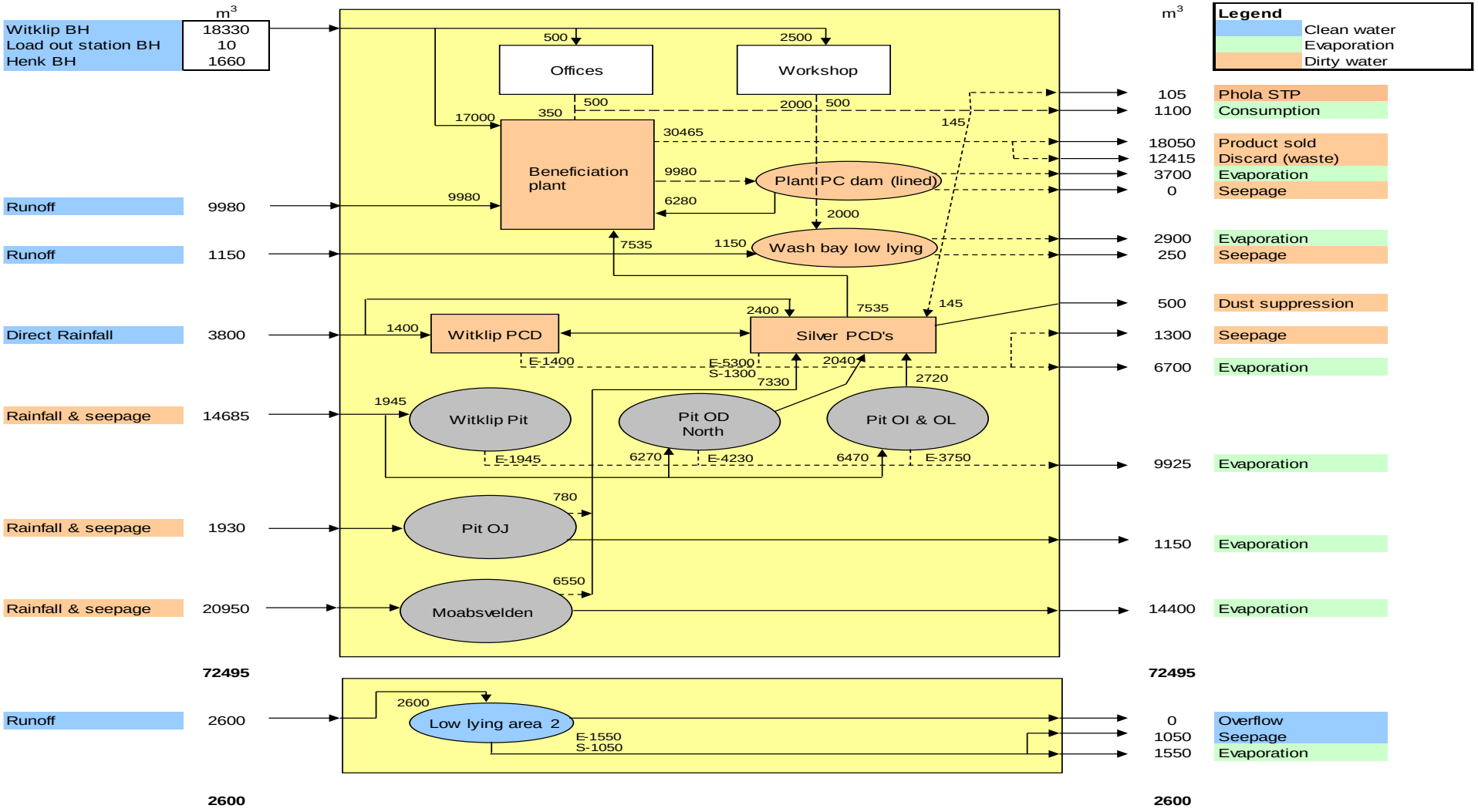
Sustainable water resource management forms part of the mine's integrated water management principles and involves the development of an integrated approach of water accounting that more accurately reflects the reality of water use on the mine.

Water accounting uses a water balance approach to quantify the amount of water entering a system (through precipitation and groundwater flows) and the amount leaving a system (through evaporation, surface water flows, sewage, product water loss and groundwater flows).

To ensure adequate storage during summer conditions the water balance were also determined for the six months summer and six months winter conditions. The summer period was taken from October to March with winter period from April to September.

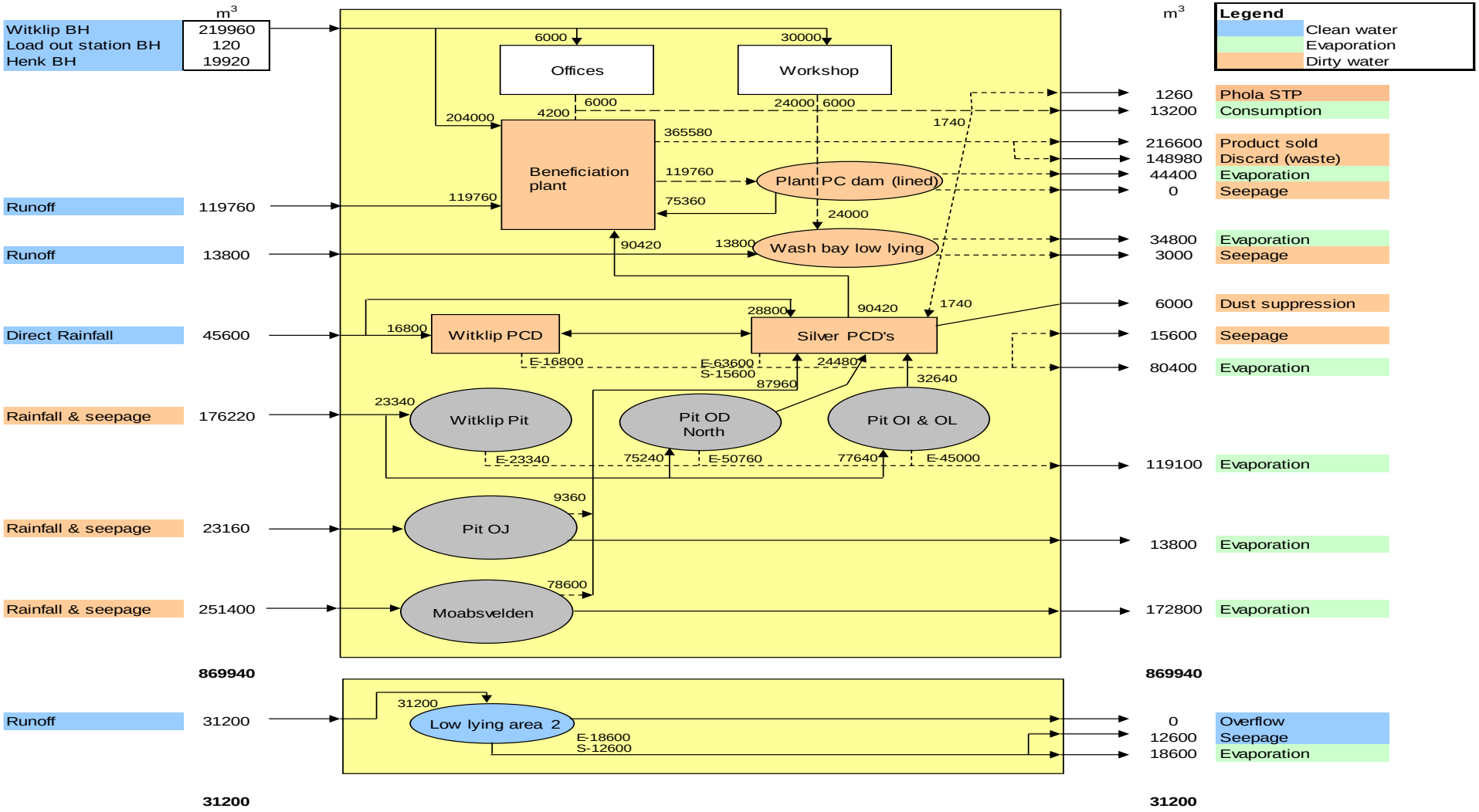
Data considered for the update has been averaged for the period **July 2019** to **June 2020**.

2. WATER BALANCE – AVERAGE MONTHLY CONDITIONS



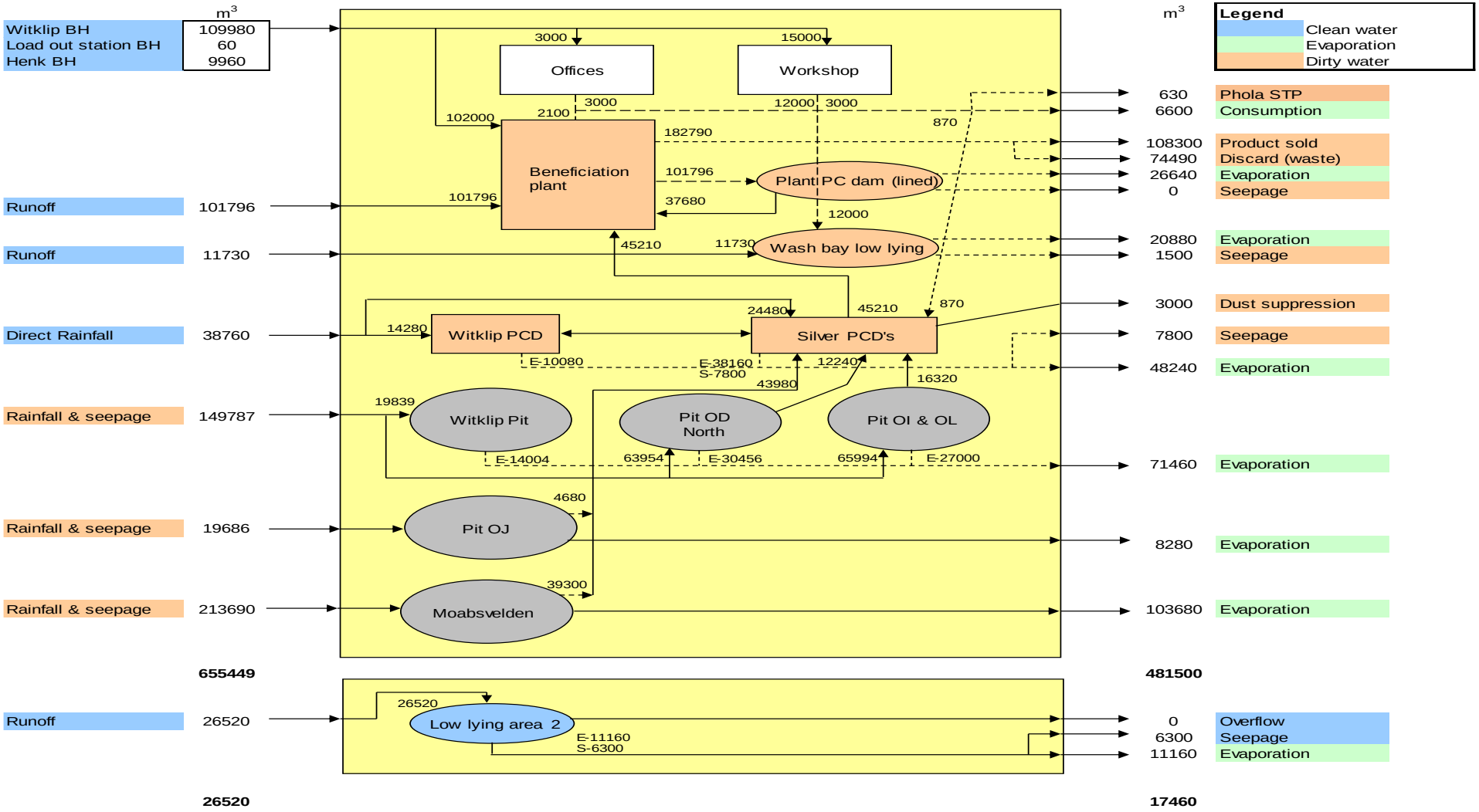
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3. WATER BALANCE – AVERAGE ANNUAL CONDITIONS



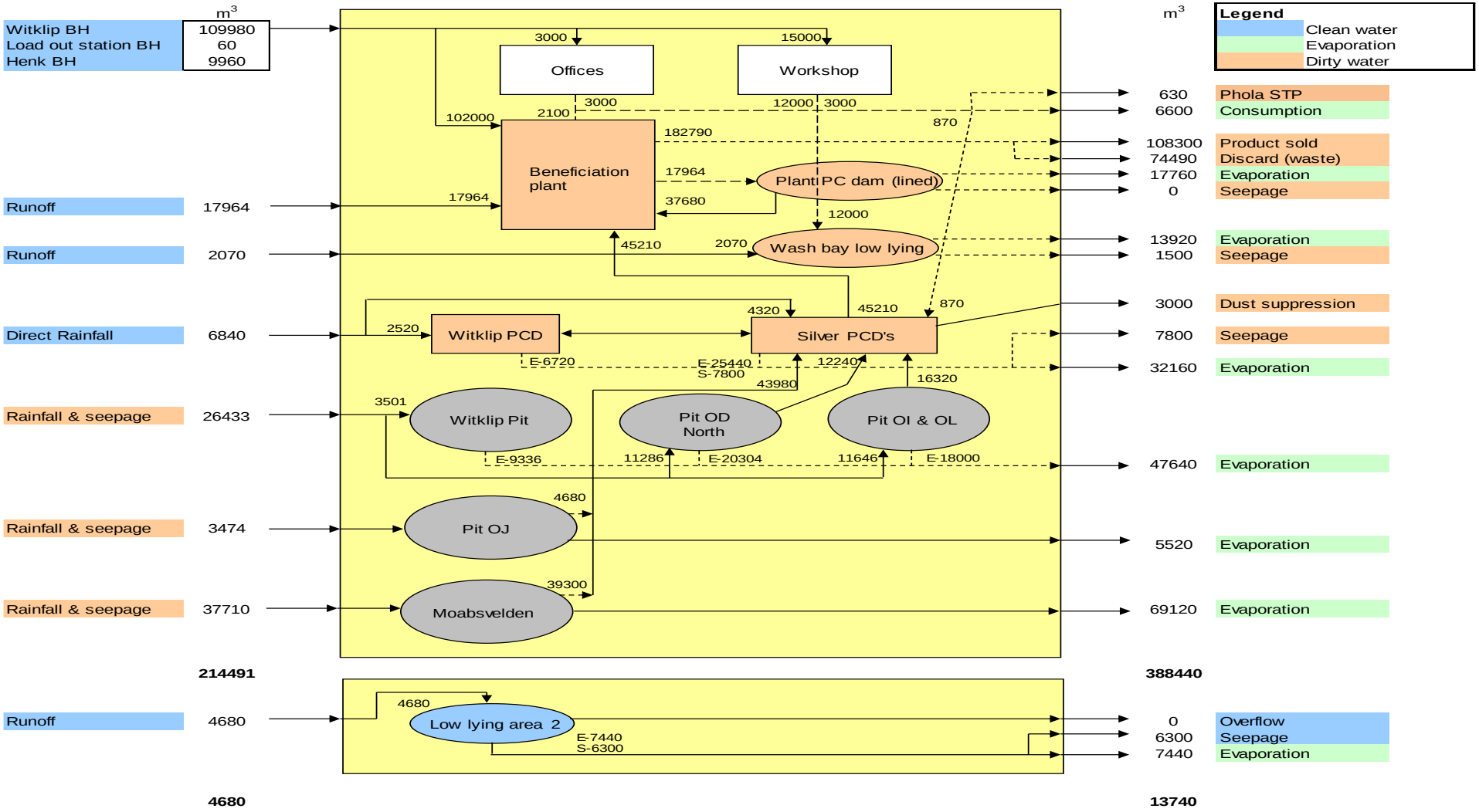
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4. WATER BALANCE – SUMMER CONDITIONS



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5. WATER BALANCE – WINTER CONDITIONS



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6. CALCULATIONS AND ASSUMPTIONS

Rainfall data:

Rainfall gauging station 0477309 W – Delmas has a record length of 92 years that stretches from hydrological year 1907/08 to 1998/99. The station lies at Latitude 26° 09' and Longitude 28° 41' with an altitude of 1556 masl. The mean annual precipitation (MAP) is estimated at 660 mm/annum.

Monthly rainfall:

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	116	92	82	39	18	6.2	6.1	8.2	22	66	99	104

Evaporation data:

The Mean Annual Evaporation (MAE) calculated for this quaternary catchment area (B20A) is 1650 mm/annum (Midgley et al, 1990).

Monthly evaporation:

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Evaporation (mm)	182	151	149	115	97	79	86	114	148	178	168	185

Rainwater & Seepage input:

Dirty water (average monthly):

Site	Catchment area (m^2)	Runoff coefficient	Rainwater inflow (m^3)
Witklip dam	26 000	1.0	1 400
Silver PCD's	43 000	1.0	2 400
Plant pollution control dam	453 000	0.4	9 980
Wash bay low lying area	52 000	0.4	1 150

The Witklip dam and Silver PCD's areas have no effective catchment area with rainfall accumulation limited to the surface area. The catchment areas of the Plant and Wash bay areas have several impermeable areas (corrugated roofs and cement slabs) similar to an industrial area with a low permeability of the soil.

Clean water (average monthly):

Site	Catchment area (m^2)	Runoff coefficient	Rainwater inflow (m^3)
Low lying area	95 000	0.5	2 600

The low lying area is fully vegetated with very shallow slopes.

It is recommended that these clean water areas be removed and re-habilitated to ensure that runoff from these catchments report to the Bronkhorstspruit catchment.

Open pits (average monthly):

Site	Catchment area (m^2)	Runoff coefficient	Rainwater & seepage (m^3)
Witklip pit	88 400	0.4	1 945
Pit OD north	285 000	0.4	6 270
Pit OI & OL	294 000	0.4	6 470
Pit OJ	87 700	0.4	1 930
Pit Moabsvelden	952 200	0.4	20 950

Seepage from the side slopes are mainly from rainfall temporarily infiltrating the soil on the slopes with the groundwater influx component relatively small (90 m^3 / month for the Witklip pit; Hodgson, 1993) in comparison. Thus the runoff coefficient was increased from the natural state to allow for this rainwater to seep out and accumulate in the open pit area.

Product and Discard losses:

Average product sold per month (2019/20) = 360 000 m^3

Average discard produced (2019/20) = 195 000 m^3

Product Loss = 18 050 m^3/month

Discard Loss = 12 415 m^3/month

Clean water intake:

The mine was requested to stop the abstraction from the Witklip borehole as it was not properly authorised in terms of the National Water Act, 1998. The mine only abstracted 5 000 m^3/month for the period 2019/20. There is currently an application to license the abstraction from the Witklip

aquifer via a set of two boreholes (a second borehole to the aquifer will act as an emergency access should the first hole collapse or in case of maintenance). In future the total abstraction will be 20 000 m^3/month from the following areas:

- Henks BH abstraction = 1 660 m^3/month (maximum 5 700 m^3/month: IWUL, 2011)
- Load station BH abstraction = 10 m^3/month (maximum 10 m^3/month: IWUL, 2011)
- Witklip BH abstraction = 18 330 m^3/month (new application)

Evaporation:

Dirty water areas and open pits (average monthly):

Site	Evaporation area (m^2)	Evaporation coefficient	Evaporation (m^3)
Witklip dam	26 000	0.9	1 655 (max)
Silver PCD's	43 000	0.9	5 300
Plant pollution control dam	30 000	0.9	3 700
Wash bay low lying area	35 000	0.6	2 900

The Wash bay low lying area are covered by reeds (approximately 80 % of the surface area) and will thus limit the evaporation potential. For the calculations a combined coefficient was determined by using a 0.5 coefficient for the vegetated area. {20% * 1.0 + 80% * 0.5 = 0.6}

Witklip dam evaporation limited to rainfall received – 1400 m^3/month.

Pit evaporation:

The following pit evaporation rates were estimated from satellite imagery for the period July 2019 to June 2020:

- Moabsvelden pit = 14 400 m^3/month
- Pit OJ = 1 150 m^3/month
- Pit OI & OL pit = 3 750 m^3/month
- Pit OD North = 4 230 m^3/month
- Witklip pit = 1 945 m^3/month

Clean water (average monthly):

Site	Evaporation area (m^2)	Evaporation coefficient	Evaporation (m^3)
Low lying area	22 800	0.5	1 550

Both low lying areas are fully vegetated, an evaporation coefficient of 0.5 is proposed.

The evaporation potential was simulated with the evaporation distribution over the hydrological year. The rainfall influx was also simulated to prevent a possible scenario where the evaporation will exceed the precipitation. In such a case the evaporation were limited to the rainfall influx. Evapotranspiration has also been included in the calculations.

Seepage:

Initial seepage rates upon filling a newly constructed pond may be as great as 10 mm/day, seepage rates decrease dramatically in a few months to a few millimetres per day. This decrease in seepage is attributed to the plugging of conducting pores in the bed material by microbial slimes and colloidal soil materials (Madramootoo, 1997).

The high clay content of the soils in the area (Hodgson, 1993) will probably limit the seepage rate to 1 - 3 mm / day. This is fairly conservative rate since the clay-lined structures were designed to seep in the order of 0.5 – 1 mm / day.

Site	Rate (mm / day)	Seepage area (m^2)	Seepage (m^3)
Witklip dam (lined)	-	HDPE lined	0
Silver PCD's	1.0	43 000	1 300
Plant pollution control dam	-	HDPE lined	0
Wash bay low lying area	1.0	12 000	250*
Low lying area	3.0	22 800	1 050*

* Seepage was reduced by 30 - 50% due to the low lying areas holding rainwater runoff during the summer months.

Dust suppression

The following dust suppression volume recorded for 2019/20:

500 m^3 / month

Sewage treatment

Sewage water is either transported to the Phola Sewage Treatment Plant (STP) or re-used on the mine via the pollution control facilities.

During 2019/20 - 105 m^3 / month to Phola and 145 m^3 / month to the dirty water holding facilities.

REFERENCES

Chandra A. Madramootoo William R. Johnston and Lyman S. Willardson, 1997. Management of agricultural drainage water quality. Water Reports 13. INTERNATIONAL COMMISSION ON IRRIGATION AND DRAINAGE. FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS Rome

Midgley DC, Pitman WV & Middleton BT, 1990. Surface water resources of South Africa – Volumes I to VI. WRC report 298/I to VI/94, Water Research Commission, South Africa

Hodgson F, 1993. Geo-hydrological investigation at the Leeuwpan and Witklip collieries with the purpose of submitting an application to the mine.

Geo-pollution Technologies, 2002. Geo-hydrological investigation at the Leeuwpan mine. Report number LPN/01/222, Pretoria, South Africa.

GCS, 2014. Leeuwpan Colliery Geo-hydrological Investigation, Report Number 11-447GW, Johannesburg, South Africa.

Annexure F
Current Licenses Issued



water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

MPUMALANGA
Private Bag x11259, Nelspruit, 1200. Prorom Building, Cnr Brown & Paul Kruger Street

Enq: L S Mautjana
E-mail: mautjanal@dwa.gov.za

Tel: 013 932 2061/4
Fax: 013 932 2071
Ref: 16/2/7/B100/C27

Exxaro Resources (Pty) Ltd
Leeuwpan Coal Mine
P. O. Box 2353
DELMAS
2210

ATTENTION: Ms. Antoinette Denton

WATER USE LICENCE FOR LEEUWPAN COAL MINE

I acknowledge the receipt of the Water Use License for Leeuwpan Coal Mine prepared by the Mpumalanga Regional Office.

Leeuwpan Coal Mine Or representative

Signature_____

Name (Print) _____

Date: _____

Regional Office representative

Signature L.L.Mautjana.

Name (Print) Lerato Mautjana.

Date: 04/04/2011

Please do not hesitate to contact the Department's Regional Office should you have any queries.

water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

Private Bag X313, Pretoria 0001, 185 Schoeman Street, Sedibeng Building, Pretoria., Tel: 012 336 7500
Fax (012) 323 4472/ (012) 326 2715. www.dwa.gov.za

LICENCE IN TERMS OF CHAPTER 4 OF THE NATIONAL WATER ACT, 1998 (ACT NO. 36 OF 1998) (THE ACT)

I, ***Deborah Gabaakelwe Mochotlhi,*** in my capacity as Project Manager: Letsema in the Department of Water Affairs and acting under authority of the powers delegated to me by the Minister of Water and Environmental Affairs, hereby authorise the following water uses in respect of this licence.

SIGNED: .....

DATE: 25/03/2011

LICENCE NO: 04/B21A/ABCGIJ/429
FILE NO: 16/2/7/B100/C27

1. **Water User:** **Exxaro Resources (Pty) Ltd – Leeuwpan Coal Mine**
   Postal Address of applicant: P O BOX 2353, DELMAS, 2210

2. **Water Uses**

2.1	Section 21(a) of the Act:	Taking of water from a water resource, subject to the conditions set out in Appendices I and II.
2.2	Section 21(b) of the Act:	Storing of water, subject to the conditions set out in Appendices I and III.
2.3	Section 21(c) of the Act:	Impeding or diverting the flow of water in a watercourse, subject to the conditions set out in Appendices I and IV
2.4	Section 21(g) of the Act:	Disposing of waste in a manner which may detrimentally impact on a water resource, subject to the conditions set out in Appendices I and IV.
2.5	Section 21(i) of the Act:	Altering the bed, banks, course or characteristics of watercourse, subject to the conditions set out in Appendices I and IV

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2.6 Section 21(j) of the Act: Removing, discharging or disposing of water found underground, subject to the conditions set out in I and V.

3. Properties on which the use will be exercised

3.1	Section 21(a) of the Act:	**Kenbar 257 IR; Moabsvelden 248 IR; Leeuwpan 246 IR; Witklip 229 IR**
3.2	Section 21(b) of the Act:	**Wolvenfontein 244 IR**
3.3	Section 21(c) of the Act:	**Moabsvelden 248 IR**
3.4	Section 21(i) of the Act:	**Moabsvelden 248 IR**
3.5	Section 21(g) of the Act:	**Kenbar 257 IR; Leeuwpan 246 IR; Witklip 229 IR;**
3.5	Section 21(j) of the Act:	**Kenbar 257 IR; Moabsvelden 248 IR; Witklip 229 IR**

4. Registered owners of the Properties

4.1 Exxaro Resources (Pty) Ltd is the registered owner of the Properties as illustrated on Title Deeds Numbers: T9659/2002 (Kenbar 257 IR Portion 0; Goedegedacht 228 IR Portion 9; Leeuwpan 246 IR Portion 3; Moabsvelden 248 IR RE of Portion 2 & 12 & 13; Witklip 229 IR Portion 4; Weltevreden 227 IR; Wolvenfontein 244 IR Portion 8), T117235/2004 (Witklip 229 IR Portion 10), T10574/2009 (Witklip 232 IR Portion 3 and 16), T5424/2008 (Mobsvelden 248 IR Portion 5 and 6), T33044/2003 (Moabsvelden 248 IR Portion 44), T70387/2004 (Moabsvelden 248 IR Portion 49).

5. Licence and Review Period

5.1 This licence is valid for a period of ten (10) years from the date of issuance and it will be reviewed every five (3) years.

6. Definitions

"Any term, word and expression as defined in the National Water Act, 1998 (Act 36 of 1998) shall bear the same meaning when used in this licence."

"The Regional Head" means the Regional Chief Director: Mpumalanga, Department of Water Affairs, and Private Bag X 10580 Bronkhorstspruit 1020

"Report" refers to the report entitled "Exxaro Coal – Leeuwpan Coal Integrated Water Use Licence Application in terms of Section 40 of the National Water Act, 1998 (Act 36 of 1998)-" dated December 2009 for Exxaro Resources (Pty) Ltd as compiled by Clean Stream Environmental Consultants as well as all other related documentation and communication (amendments, emails, letters, verbal, etc.) related thereto.

7. Description of the activity

Leeuwpan Coal Mine owned by Exxaro Resources Ltd is existing opencast coal mining located in the Mpumalanga Province in the Delmas Magisterial District. The mine is situated in the upper reaches of the Bronkhorstspruit Catchment within quaternary drainage B20A. The mining process is conducted by truck and shovel roll-over mining technique.

APPENDIX I

General conditions for the licence

1. This licence is subject to all applicable provisions of the National Water Act, 1998 (Act 36 of 1998).

2. The responsibility for complying with the provisions of the licence is vested in the licensee and not any other person or body.

3. The Licensee must immediately inform the Regional Head of any change of name, address, premises and/or legal status.

4. If the property in respect of which this licence is issued is subdivided or consolidated, the licensee must provide full details of all changes in respect of the properties to the Regional Head of the Department within 60 days of the said change taking place.

5. If a water user association is established in the area to manage the resource, membership of the licensee to this association is compulsory.

6. The Licensee shall be responsible for any water use charges or levies imposed by a responsible authority.

7. While effect must be given to the Reserve as determined in terms of the Act, where a desktop determination of the Reserve has been used in issuance of a licence, when a comprehensive determination of the Reserve has finally been made; it shall be given effect to.

8. When compulsory licensing is implemented for the water resource in respect of which this licence was issued, the water use authorised in this licence could be subject to appropriate reduction.

9. The licence shall not be construed as exempting the licensee from compliance with the provisions of any other applicable Act, Ordinance, Regulation or By-law.

10. The licence and amendment of this licence are also subject to all the applicable procedural requirements and other applicable provisions of the Act, as amended from time to time.

11. The Licensee shall conduct an annual internal audit on compliance with the conditions of licence. A report on the audit shall be submitted to the Regional Head within one month of the finalisation of the audit.

12. The Licensee shall appoint an independent external auditor to conduct an annual audit on compliance with the conditions of this licence. The first audit must be conducted within 3 (three) months of the date this licence and a report on the audit shall be submitted to the Regional Head within one month of finalisation of the report.

13. Flow metering, recording and integrating devices shall be maintained in a sound state of repair and calibrated by a competent person at intervals of not more than two years. Calibration certificates shall be available for inspection by the Regional Head or his representative upon request.

14. Any incident that causes or may cause water pollution shall be reported to the Regional Head or his/her designated representative within 24 hours.

APPENDIX II

Section 21 (a) water use: Taking water from a water resource

1. This licence authorises the taking of a maximum quantity as follows in Table 1:-

Table 1

Water Uses	Areas	Volumes	Co-ordinates
Taking of water from the Henks Borehole	Kenbar 257 IR	68 400 m³/a	S26°09'50,0" E28°43'15.5"
Abstraction of wastewater from Block OD open pit		24 000 m³/a	S26°10'41.6" E28°43'26.3"
Abstraction of wastewater from Block OM & OH open pit		26 400m³/a	S26°10'24.2" E28°44'58.4"
Abstraction of wastewater from Block OJ open pit	Moabsvelden 248 IR	15 360 m³/a	S26°09'49,2" E28°45'45,2"
Abstraction of wastewater from Block OWM open pit		15 360 m³/a	S26°08'36,5" E28°46'49,5"
Devon load cut borehole	Leeuwpan 246 IR	120 m³/a	S26°10'46.8" E28°43'43.4"
Witklip open pit – opencast pit seepage of ground water	Witklip 229 IR	20 000 m³/a	S26°10'06.4" E28°42'19.3"

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2. The quantity of water authorised to be taken in terms of this licence may not be exceeded without prior authorisation by the Minister.

3. This licence does not imply any guarantee that the said quantities and qualities of water will be available at present or at any time in the future.

4. The abovementioned volume may be reduced when the licence is reviewed.

5. The licensee shall continually investigate new and emerging technologies and put into practice water efficient devices or apply technique for the efficient use of water containing waste, in an endeavour to conserve water at all times.

6. The Department accepts no liability for any damage, loss or inconvenience, of whatever nature, suffered as a result of:

   9.1 shortage of water
   9.2 inundations or flood
   9.3 siltation of the resource; and
   9.4 required reserve releases.

7. The licensee shall establish and implement a continual process of raising awareness amongst itself, its workers and stakeholders for the need to conserve water and implement various Water Conservation and Water Demand Management (WC/WDM) measures.

8. All water taken from the resource shall be measured as follows:

8.1 the daily quantity of water taken must be metered or gauged and the total recorded at the last day of each month; and

8.2 the licensee shall keep record of all water taken and a copy of the records shall be forwarded to the Regional Head on or before 25 January and 25 July of each year.

9. No water taken may be pumped, stored, diverted, or alienated for purposes other than intended in this licence, without written approval by the Minister or his/her delegated nominee.

10. The licensee shall install and monitor appropriate water measuring device to measure the amount of water abstracted, received and/or consumed, as applicable to the infrastructure.

11. Notices prohibiting unauthorised persons from entering the certain areas, as well as internationally acceptable signs indicating the risks involved in case of an unauthorised entry must be displayed along the boundary fence of these areas.

12. The licensee shall ensure that all measuring devices are properly maintained and in good working order and must be easily accessible. This shall include a programme of checking, calibration, and/or renewal of measuring devices.

13. The licensee shall establish a programme of formal Information Management System, which maintains a database on water supply, distribution and delivery infrastructure.

APPENDIX III

Section 21 (b) of the Act: Storing of water

1. STORING OF WATER

1.1 This licence is authorises to store a maximum quantity of water as follows in Table 2:-

Table 2

Water Uses	Areas	Storage Volumes	Co-ordinates
Low lying area 2 • Storage capacity varying • Circular • Unlined	Wolvenfontein 244 IR	188 000 m³	S26°11'09.8" E28°42'33.1"

1.2 The licensee must obtain any proprietary rights or servitudes at their own cost.

1.3 The Licensee is not indemnified from any detrimental effect that the dam(s) may have on other properties. The Department does not accept any responsibility or liability for any damages or losses that may be suffered by any other party as a result of the construction and utilisation of the dams.

1.4 The licensee shall ensure that the dam has the capacity to store any additional water and no additional water storage facilities can be constructed on the property without prior written consent of the Minister or responsible authority.

2. Monitoring Requirements

2.1 The Licensee is not indemnified from any detrimental effect that the dam(s) may have on other properties. The Department does not accept any responsibility or liability for any damages or losses that may be suffered by any other party as a result of the construction and utilisation of the dams.

2.2 Suitable measuring structures must be constructed upstream and downstream of the dams to measure the flow entering and leaving the dams and this information must be available on request.

2.3 The Liicensee shall establish a monitoring programme and the date and time of monitoring in respect of each sample taken shall be recorded together with the results of

the analysis as well as other significant information (low flow, flooding, pollution incident, etc.).

2.4 The quantity of water stored shall be recorded as at the last day of each month.

3. Dam Safety Requirements

3.1 The construction, operation, and maintenance of all dam facilities classified as a dam with a safety risk, must be carried out under supervision of a Professional Civil Engineer, registered under the Engineering Profession of South Africa Act, 1990 (Act 114 of 1990).

3.2 All storage facilities (for water not containing waste) with a safety risk will comply to the following control measures:

3.3 The Licensee shall supply any information, drawings, specifications, design assumptions, calculations, documents and test results when requested by the Regional Head.

3.4 An approved professional person must be appointed to carry out a dam safety evaluation annually and must:

3.4.1 Consider whether the safety norms pertaining to the design, construction, monitoring, operation, performance and maintenance of the dam satisfy acceptable dam engineering practices.

3.4.2 Compile a report on the matters contemplated above, according to the prescribed requirements and submit the signed and dated report to the owner of the dam within the prescribed period.

3.5 The Licensee is not exempted from compliance with the provisions of the Regulations published under Government Notice R1560 of 25 July 1986, read with Chapter 12 of the Act.

4. Construction of Dam(s)

4.1 The as-built plans and specifications of the dam(s) must be submitted to the Regional Head for his/her records.

4.2 Construction of the dam(s) may not commence before authorisation in terms of the Environment Conservation Act, 1989 (Act 73 of 1989) is issued.

4.3 The Government reserves the right to construct storage works at any time in any stream and to store all surplus water reaching the dam(s) and to control the allocation of such water.

4.4 Construction of the dam(s) may not commence unless the required authorisation to build has been issued by the Dam Safety Office of this Department.

Licence No: 04/B21A/ABCGIJ/429
File No: 16/2/7/B100/C27

APPENDIX IV

Section 21(c) of the Act: **Impeding or diverting the flow of water in a watercourse;**

Section 21(i) of the Act: **Altering the bed, banks, course or characteristic of a watercourse**

1. Construction, Operation and Maintenance

1.1 The licensee shall carry out and complete all the activities according to the following:

Water Uses	Areas	Storage Volumes	Co-ordinates
Block OWM River diversion – Weltevreden tributary of the Bronkhorstspruit	Moabsvelden 248 IR	Height = 3m Width = 10m Length = 2.1km Flow rate (before = 1.8; after = 2.31 m^3/s)	S26°08'36, 5" E28°46'49, 5"

1.1.1 Report(s) submitted to the Department or the Responsible Authority;

1.1.2 Conditions of this licence; and

1.1.3 Any other written direction issued by the Regional Head in relation to this licence.

1.2 The licensee must submit a set of as-built drawings (not schematic layouts) to the Regional Head of all river diversions, road crossings and weirs.

1.3 The conditions of the authorisation shall be brought to the attention of all persons (employees, sub-consultants, contractors etc.) associated with the undertaking of this activity and the applicant shall take such measures that are necessary to bind such persons to the conditions of this licence.

1.4 Construction activities must not take place within the 1:100 year flood-line or within a horizontal distance of 100 meters from any watercourse, estuary, borehole or well, whichever is the greatest, unless authorised by this licence (as part of the activities described in the report(s) (referred to in condition 1.2) submitted to the Department).

1.5 Compensation measures for damage to and or mitigation measures must be recommended if avoidance or minimisation of the impacts of the proposed development is not possible or if mitigation measures fail to adequately protect the in-stream and riparian habitat.

1.6 No material with pollution generating potential will be used in any construction

activities.

1.7 The necessary erosion prevention mechanisms shall be employed to ensure the sustainability of all structures.

1.8 The licensee must ensure that structures such as the river diversions, river road crossings, weirs and the culverts shall not be damaged excessively by floods exceeding the magnitude of floods occurring on average once in every 100 years.

1.9 The structure of temporary crossings must be non-erosive, structurally stable and must not induce any flooding or safety hazard. Temporary crossings must be inspected regularly for accumulation of debris, blockage, erosion of abutments and overflow areas. Debris must be removed and damages must be repaired and reinforced immediately.

1.10 Construction activities shall start up-stream and proceed into a down-stream direction, so that the recovery processes can start immediately, without further disturbance from upstream construction works.

1.11 Construction activities must be scheduled to take place during the dry seasons when flows are lowest.

1.12 The natural migration of aquatic biota and upstream movement of fish must not be disturbed.

1.13 The development may not impede natural drainage lines.

1.14 The construction camp shall not be located within the 1:100 year flood line or within 100 meters of any watercourse whatever the greatest.

1.15 Vehicles and other machinery must be serviced well above the 1:100 year flood line or within a horizontal distance of 100 meters from any watercourse or estuary. Oils and other potential pollutants must be disposed off at an appropriate licensed site, with the necessary agreement from the owner of such a site.

1.16 All reagent storage tanks and reaction units must be supplied with a bunded area built to the capacity of the facility and provided with sumps and pumps return the spilled material back into the system.

1.17 The system shall be maintained in a state of good repair and standby pumps must be provided.

1.18 Any hazardous substances must be handled according to the relevant legislation relating to transport, storage and use of the substance.

1.19 Pollutions caused by spills from the conveyances must be prevented through proper maintenance and effective protective measures especially near all stream crossings.

1.20 Any access roads or temporary crossings should be:

1.20.1 non-erosive, structurally stable and should not induce any flooding or safety hazard;

1.20.2 any damage be repaired immediately to prevent further damage.

1.21 Road and bridge crossing must be constructed to lie perpendicular across a wetland not diagonally as this will create preferential low paths, which will desiccate the wetlands.

1.22 Disturbance zones must be limited along the construction area of the tributary and the channelled valley bottom wetland. The construction footprint of the crossing must be rehabilitated.

2. Storm water Management

2.1 Storm water shall be diverted from the construction works and roads and shall be managed in such a manner as to disperse runoff and to prevent the concentration of storm water flow.

2.2 Where necessary, works must be constructed to attenuate the velocity of the storm water discharge and to protect the banks of the watercourse.

2.3 Storm water control works must be constructed, operated and maintained in a sustainable manner throughout the project.

2.4 Increased runoff due to vegetation clearance and/or soil compaction must be managed, and steps must be taken to ensure that storm water does not lead to bank instability and excessive levels of silt entering the watercourse.

2.5 Storm water leaving the licensee's premises must in no way be contaminated by any substance, whether such substance is a solid, liquid, vapour or gas or a combination thereof which is produced, used, stored, dumped or spilled on the premises.

3. Water Quality and Quantity

3.1 The in-stream water quality must be analysed on weekly basis during the construction of the activities of the river diversion, at the monitoring points for both upstream and downstream of the activities for the river diversion for the following variables: pH, Electrical conductivity (mS/M), suspended solids (mg/l), and total dissolved solids (mg/l). Monitoring shall continue on monthly basis for three months after the cessation of the activities.

3.2 Activities (such as maintenance) that lead to elevated levels of turbidity of any watercourse must be minimised.

3.3 The Licensee shall ensure that the quantity of the water to downstream water users does not decrease because of the existence of the river diversions, river crossings, culverts and associated maintenance of road crossings.

4. General Specifications

4.1 A suitably qualified person, appointed by the Licensee, and approved, in writing, by the Regional Head, must be responsible for ensuring that the structures are maintained in line with the design specifications.

4.2 The Licensee shall have a full time Civil Engineer Supervisor on the site during construction of river diversions, river crossings and culverts. The contractor shall have an approved Site Agent on the site during construction.

4.3 The Licensee must ensure that river diversions, river road crossings, weirs and the culverts shall not be damaged excessively by floods exceeding the magnitude of floods occurring on average once in every 100 years.

4.4 Development activities should start upstream and work downstream, so that the recovery process can start immediately, without further disturbance from upstream disturbances.

4.5 The necessary erosion prevention mechanisms shall be employed to ensure the sustainability of all the structures.

4.6 Where temporary crossings are included their structure must be non-erosive, structurally stable and may not induce any flooding or safety hazard. Temporary crossings must be inspected regularly for accumulation of debris, blockage, erosion of abutments and overflow areas. Damaged areas shall be repaired and reinforced immediately.

4.7 The Licensee must submit a set of as-built detailed drawings (not schematic layouts) to the Regional Head of all river diversions, road crossings, and weirs, when required.

4.8 The Licensee shall deliver proof to the Regional Head of compliance with the following, when required:

4.9 The Licensee must ensure the placement of advertisements of the alteration activities in local newspapers and one regional newspaper as required by the M1.0 Operational Guideline for the control over the alteration of a watercourse.

5. Protective Measures

5.1 The diversion structures may not restrict river flows by reducing the overall river width or obstructing river flow.

5.2 Operation and storage of equipment within the riparian zone must be limited as far as possible.

5.3 All activities within the riparian zone should be restricted as far as possible.

5.4 Any material removed from the in stream or riparian habitat, may not be stored within the riparian zone, and may not be stored in such a way that will cause damming of water or wash-away.

5.5 Alien vegetation must not be allowed to further colonise the area, and all new alien vegetation recruitment must be eradicated or controlled, using standard methods approved by the Department.

5.5 Soils that have become compacted through the activities of the development must be loosened to an appropriate depth to allow seed germination.

5.6 The proposed development must not impede the upstream movement of fish.

5.7 Increased runoff due to vegetation clearance and/or soil compaction must be managed and steps must be taken to ensure that storm water does not lead to bank instability and excessive levels of silt entering the stream.

5.8 Riparian vegetation, including dead trees, may not be removed from the area. In particular, snags (fallen trees and branches) in the river must be protected (i.e. not collected for firewood or any other purpose).

5.9 All reasonable steps should be made to minimise noise and mechanical vibrations in the vicinity of the river.

5.10 Considerations should be given for using small earthern berms or small drop –inlet structures on the upslope side of the road crossing at each of the culverts and energy dissipaters on the down slope end will reduce the effects of the flow concentrations and reduce the risk of soil erosion.

6. Rehabilitation

6.1 All disturbed areas must be re-vegetated with an indigenous seed mix in consultation with an indigenous plant expert, ensuring that during rehabilitation only indigenous shrubs, trees and grasses are used in restoring the biodiversity.

6.2 The vegetation of the surrounding catchment should also be managed to prevent erosion and siltation of the water course.

6.3 The Licensee shall take steps necessary to allow movement of aquatic species, including migratory species during the rehabilitation programme.

6.4 The licensee shall embark on a systematic long-term rehabilitation programme to restore natural watercourses to environmentally acceptable and sustainable conditions after construction, which shall include, but not be limited to:

6.4.1 The rehabilitation of disturbed and degraded riparian areas to restore and upgrade the riparian habitat integrity to sustain a bio-diverse riparian ecosystem; and

6.4.2 Annually assess the habitat to monitor the sustainability of the diversions and compliance with these conditions. Action must be taken to rectify any negative impacts.

6.5 The Licensee shall ensure that the volume of flow is not reduced except for natural evaporative losses and the authorised attenuation volumes.

5.5 Alien vegetation must not be allowed to further colonise the area, and all new alien vegetation recruitment must be eradicated or controlled, using standard methods approved by the Department.

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6.4.2 Annually assess the habitat to monitor the sustainability of the diversions and compliance with these conditions. Action must be taken to rectify any negative impacts.

6.5 The Licensee shall ensure that the volume of flow is not reduced except for natural evaporative losses and the authorised attenuation volumes.

7. General Surface Water Design Requirements and Criteria

7.1 The Licensee shall determine flood lines (1:50 and 1:100 year) prior to construction to ensure risks are adequately managed. Flood lines shall be clearly indicated on the layout plans.

7.2 The Licensee shall schedule construction activities at or close to river crossings, streams or wetlands to take place during low flow periods.

7.3 The Licensee shall clearly indicate all wetlands boundaries within the project area on layout plans.

7.4 Design and planning of all proposed construction activities adjacent to or in the vicinity of rivers, streams and wetlands shall consider the following measures:

7.4.1 Impact of alignment on springs and wetlands shall be investigated and monitored and ensure their continued functioning.

7.4.2 Where appropriate, large individual indigenous riparian trees shall be avoided during construction and shall be clearly marked on site.

7.4.3 All construction roads in or adjacent to the riparian zone shall be minimised and if required, shall be aligned and managed so as to minimise disturbance of the riparian zone and in-stream habitats.

7.5 The Licensee shall do bio-monitoring to determine the impact, change, deterioration and improvement of the aquatic system associated with the activities that of impeding, altering or diverting the water resource.

APPENDIX V

Section 21 (g) water use: Disposing of waste in a manner which may detrimentally impact on a water resource

1. GENERAL

1.1 This licence authorises the Section 21(g) water use activities as set out in table below and in the water use licence application reports submitted to the Department or the Responsible Authority (refer condition 1.2):

Table 1.1

Water Uses	Areas	Volumes	Co-ordinates
Dirty runoff and process water used for dust suppression in the dirty water management area	Kenbar 257 IR	6 552 m³/a	S26°10'45.4" E28°43'58.0"

Water Uses	Areas	Storage Volumes	Co-ordinates
Disposing of waste into the pollution control dam in a manner which may detrimentally impact on a water resource - septic tank. All this tanks are all transported via honey sucker to the 7 m³ STP located at the mining green area	Kenbar 257 IR	10m³	S26°10'53.1" E28°44'20.4"
		10m³	S26°10'54.8" E28°44'17.5"
		10m³	S26°10'55.4" E28°44'18.5"
		10m³	S26°10'56.2" E28°44'16,9"
		10m³	S26°10'57.7" E28°44'20.2"
		10m³	S26°11'09.2"

Water Uses	Areas	Storage Volumes	Co-ordinates
			E28°43'46.4"
		10m³	S26°11'06.4" E28°43'36.5"
		10m³	S26°11'08.4" E28°43'36.5"
		10 m³	S26°11'08.4" E28°43'37.3"
		10 m³	S26°11'10.2" E28°43'38.1"
Disused slimes dam 1&2 that are lined with composite lining system	Kenbar 257 IR	Foot Print Area = 2.1 ha Height = 2.5m Length = 40m Breadth = 15m Volume = 88800 m³	S26°10'58.6" E28°43'53.4"
Disused slimes dam 3 that are lined with composite lining system		Foot Print Area = 1.4 ha Height = 2.5m Length = 40m Breadth = 15m Volume = 111500 m³	S26°10'58.6" E28°43'53.4"

Water Uses	Areas	Storage Volumes	Co-ordinates
Plant reuse raw water dam compartment 1 – collects contaminated water from the witklip evaporation dam, mobile pit water tank, washbay low lying area and Block OD		Foot Print Area = 2.1 ha Height = 2.7m Length = 10m Breadth = 10m Volume = 51000 m³	S26°10'52.9" E28°43'51.6"
Plant reuse raw water dam compartment 2 – collects contaminated water from the witklip evaporation dam, mobile pit water tank, washbay low lying area and Block OD		Foot Print Area = 2.2 ha Height = 2.6m Length = 10m Breadth = 10m Volume = 55000 m³	S26°10'48.9" E28°43'51.0"
Washbay Low lying area – the low lying area collects clear water from the oil separator at the workshop & washbay as well as runoff from the washbay for reuse at the washbay or its pumped to the plant raw water dams - unlined		Foot Print Area = 0.6 ha Height = 0.5m Length = 250m Breadth = 100m Volume = 3007 m³	S26°10'55.4" E28°44'16.0"
Mobile Pit Water Tank – this tank collects contaminated water pumped from the open pits and is pumped to the plant raw water dams – steel tank		Foot Print Area = 0.003 ha Height = 2 m Length = 6 m Breadth = 6 m Volume = 60 m³	S26°10'24.9" E28°44'30.0"

Water Uses	Areas	Storage Volumes	Co-ordinates
Process water storage Tank 3 – process water from the plant is stored in this tank – steel tank		Foot Print Area = 0.035 ha Height = 3 m Length = 0 m Breadth = 0 m Volume = 1050 m^3	S26°10'21.7" E28°43'51.0"
Process water storage Tank 4 - process water from the plant is stored in this tank – steel tank		Foot Print Area = 0.023 ha Height = 4.7 m Length = 0 m Breadth = 0 m Volume = 1081 m^3	S26°10'21.7" E28°43'51.0"
Plant Raw Water Tank 1 – contaminated water from the plant raw water dams are stored in this dam for reuse – steel tank		Foot Print Area = 0.007 ha Height = 2.5 m Length = 0 m Breadth = 0 m Volume = 166 m^3	S26°10'21.7"

Water Uses	Areas	Storage Volumes	Co-ordinates
Workshop Raw Water Tank – this tank stores contaminated water from the plant raw water dams for use at the wash bay – steel tank		Foot Print Area = 0.003 ha Height = 2.0 m Length = 0 m Breadth = 0 m Volume = 60 m³	E28°43'51.0"
In-pit backfilling – disposal of plant discard from filter press and over burden into the open pits Foot print area>total area of property on which waste is disposed		Foot Print Area = 1 548 ha Height = 0 m Length = 0 m Breadth = 0 m Volume = 6 432 m³/day	S26°10'54.3" E28°44'18.8"
Low-lying area 1 - This was an internal catchment area that exists as a result of the location of the infrastructure and the pits at blocks OH, OM and OD. Only clean runoff was contained in this area. The water surface area at full supply level is 9.50 hectares. But the area has in the mean time been cleaned up, and filled and compacted to be used as product stockpile area. This will be used to contain run-off water from product stockpile beds		Foot Print Area = 2.1 ha Height = 8 m Length = 100 m Breadth = 25 m Volume = 30 000 m³/a	S26°10'21.7" E28°43'51.0"

Water Uses	Areas	Storage Volumes	Co-ordinates
Conservancy Tank 1 – linked to STP of 4 m³ situated at plant offices	Leeuwpan 246 IR	10 m³	S26°10'19.6" E28°43'47.4"
Conservancy Tank 2 - linked to STP of 4 m³ situated at plant offices		10 m³	S26°10'17.3" E28°43'49.3"
Conservancy Tank 3 - linked to STP of 4 m³ situated at plant offices		10 m³	S26°10'18.8" E28°43'50.7"
Conservancy Tank 6 - linked to STP of 4 m³ situated at plant offices		10 m³	S26°10'15.7" E28°43'41.1"
Conservancy Tank 7 – cleaned by Honey Sucker and disposed into STP of 4 m³ situated at plant offices		10 m³	S26°10'17.5" E28°43'39.9"
Conservancy Tank 8 – cleaned by Honey Sucker and disposed into STP of 4 m³ situated at plant offices		10 m³	S26°10'24.5" E28°43'40.7"
Conservancy Tank 16 – cleaned by Honey			

Water Uses	Areas	Storage Volumes	Co-ordinates
Sucker and disposed into STP of 4 m³ situated at plant offices		10 m³	S26°10'22.5" E28°43'40.6"
Conservancy Tank 19 – cleaned by Honey Sucker and disposed into STP of 4 m³ situated at plant offices		10 m³	S26°09'57.8" E28°43'47.8"
Package Sewage Treatment Plant		7 m³	S26°10'52.4" E28°44'22.2"
		4 m³	S28°95365" E26°92553"
Plant Pollution Control Dam – the dam collects runoff from the plant and the coal product stockpiles that is used for dust suppression – Lined dam, composite lining system		Ha coverage = 2.1 ha H = 1.7 m L = 200 m B = 100 m V = 90 000 m³	S26°10'02.8" E28°43'28.5"
Load Out Evaporation Dam – Direct rainfall at the load-out station is collected and left out to evaporate – Not lined		Ha coverage = 0.5 ha H = 1.5 m L = 25 m B = 50 m	S26°09'49.2" E28°43'51.6"
Process water storage Tank 1 – Process water tank 1 stores process water used at the plant – Steel Tank			S26°10'15.6" E28°43'41.7"

Water Uses	Areas	Storage Volumes	Co-ordinates
Process water storage Tank 2 – Process water storage tank 2 stores process water to be used in the plant – Steel Tank		Intake water – 5328 and 20 000 m³ Ha coverage = 0.038 ha H = 3m Vol. Used 1140 m³	S26°10'15.6" E28°43'41.7"
Plant raw water Tank 2 – the tank stores contaminated water from the plant raw water dams for reuse at the plants – Steel tank		Intake water – 5328 and 20 000 m³ Ha coverage = 0.038 ha H = 3m Vol. Used 1140 m³	S26°10'15.6" E28°43'41.7"
Jig thickener Dam – contains water from the Jig plant dirty water management system – Steel Dam		Intake water – 5328 and 20 000 m³ Ha coverage = 0.0063 ha H = 4.7m Vol. Used = 296 m³	S26°10'14.5" E28°43'41.6"
Jig Clarified Dam – contains water from the Jig plant water management system – steel dam		Ha coverage = 0.00263 ha H = 4.5m Vol. Used = 740	

Water Uses	Areas	Storage Volumes	Co-ordinates
		m^3 Intake water –3 000 m^3 Ha coverage = 0.00035 ha H = 4.5m Vol. Used = 160 m^3	S26°10'14.5" E28°43'41.6"
Witklip return water dam (Reg. 24059135) – process water from the plant is stored in this return dam. Sized to accept seepage from the under drainage system and decant system for up to the 1:50 year rainfall event, over and above normal operating conditions	Witklip 229 IR	Intake water 5328 (a) & 20 000 (j) Ha coverage = 50 ha H = 4 m L = 100 m B = 200 m	S26°10'23.5" E28°42'26.3"
Witklip Evaporation Dam – the dirty storm water collected in this dam is left to evaporate – Lined with clay – application made with Dam Safety Office		Intake water 5328 (a) & 20 000 (j) Ha coverage = 3.3 ha H = 5.9 m L = 50 m B = 50 m	S26°10'23.5" E28°42'26.3"

Water Uses	Areas	Storage Volumes	Co-ordinates

1.2 The licensee must carry out and complete all the activities listed under condition 1.1 according to the following:

1.2.1 Reports submitted to the Department or the Responsible Authority, specifically:

1.2.1.1 Exxaro Coal – Leeuwpan Coal IWWMP – December 2009

1.2.1.2 Proposed stream alteration at Weltevreden Mine section Design Report

1.2.1.3 Detailed Storm water management design and plan for the mine by Greene Consultant

1.2.1.4. Surface Water Report for EIA & EMP – February 2007

1.2.1.5 Block OWM Baseline Surface Hydrology Report – November 2007

1.2.1.6 Annual Water Quality Assessment Report May 2008 to April 2009

1.2.1.7 Leeuwpan Wetland Assessment of Fauna and Flora Report No: E464/06

1.2.1.8 Wetland Assessment study for the Leeuwpan Coal Mine on the farms Moabsvelden, Rietkuil and Wolwefontein in Delmas Area – report no 303A/2007 – May 2007

1.2.1.9 Geohydrological Evaluation: Environmental Management Program report for the proposed new open pit collieries at Weltevreden – Report no: CLP/04/512 October 2004

1.2.1.10 Leeuwpan Colliery: Report on Geohydrological Investigation as part of the EMPR for the proposed Wolwenfontein, Weltevreden and Rietkuil projects April 2007

1.2.1.11 Groundwater Monitoring Report for Leeuwpan Colliery: April 2008 to May 2009

1.2.1.12 GN 704 Audit – Environmental Audit Report findings and recommendations, report No S0246/01 – May 2008

1.3 Any other written direction issued by the Regional Head in relation to this licence.

1.4 No activity must take place within the extent of a watercourse/s, unless authorised by this licence.

2. FURTHER STUDIES AND INFORMATION REQUIREMENTS

2.1 For water use activities set out in tables in this Appendix, a comprehensive groundwater monitoring programme together with IWWMP must be finalised and submitted to the Regional Head for approval.

2.2 For all the water use activities set out in tables, a preliminary and feasibility studies for the collection, treatment and discharge of mine contaminated water in all existing and dormant sections of the mine must be conducted, presented to and discussed with the Regional Head for approvals in preparation for future decants since evidence of seepage of polluted water and acid mine drainage already exist in the mine.

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2.3 The geochemical assessment study and management measures both during operations and post operations must be conducted and submitted together with IWWMP to the Regional Head.

3. CONSTRUCTION AND OPERATION

3.1 The licensee shall carry out and complete all the activities, including the construction and operation according to the design reports submitted and as approved by the Regional Head.

3.2 The construction of the discard dumps and septic tank must be carried out under the supervision of a professional Civil Engineer, registered under the Engineering Profession of South Africa Act, 1990 (Act 114 of 1990), as approved by the designer.

3.3 Within 30 days after the completion of the activities referred here in accordance with the relevant provisions of this licence, the licensee shall in writing, under reference 16/2/7/B100/C27, inform the Regional Head thereof. This shall be accompanied by a signature of approval from the designer referred to above that the construction was done according to the design plans referred to in the Report.

3.4 The Licensee must ensure that the disposal of the dirty water and the operation and maintenance of the system are done according to the provisions in the Report.

3.5 The Licensee shall use acknowledged methods for sampling and the date, time and sampler must be indicated for each sample.

3.6 Flow metering devices shall be maintained in a sound state of repair and calibrated by a competent person at intervals of not more than once in two years. Calibration certificates shall be available for inspection by the Regional Head or his representative upon request.

2. STORAGE OF WATER CONTAINING WASTE

2.1 The Licensee is authorised to dispose a maximum quantity of the following water uses per locality within the farm as mentioned in Table 2.1 below:

Table 2.1:

Water Uses	Areas	Storage Volumes	Co-ordinates
Disposing of waste into the pollution control dam in a manner which may detrimentally impact on a water resource - septic tank. All this tanks are all transported via honey sucker to the 7 m³ STP located at the mining green area	Kenbar 257 IR	10m³	S26°10'53.1" E28°44'20.4"
		10m³	S26°10'54.8" E28°44'17.5"

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Water Uses	Areas	Storage Volumes	Co-ordinates
		10m³	S26°10'55.4" E28°44'18.5"
		10m³	S26°10'56.2" E28°44'16,9"
		10m³	S26°10'57.7" E28°44'20.2"
		10m³	S26°11'09.2" E28°43'46.4"
		10m³	S26°11'06.4" E28°43'36.5"
		10m³	S26°11'08.4" E28°43'36.5"
		10 m³	S26°11'08.4" E28°43'37.3"
		10 m³	S26°11'10.2" E28°43'38.1"
Disused slimes dam 1&2 that are lined with composite lining system	Kenbar 257 IR	Foot Print Area = 2.1 ha Height = 2.5m Length = 40m Breadth =	S26°10'58.6" E28°43'53.4"

Water Uses	Areas	Storage Volumes	Co-ordinates
Disused slimes dam 3 that are lined with composite lining system		15m Volume = 88800 m³ Foot Print Area = 1.4 ha Height = 2.5m Length = 40m Breadth = 15m	S26°10'58.6" E28°43'53.4"
Plant reuse raw water dam compartment 1 – collects contaminated water from the witklip evaporation dam, mobile pit water tank, washbay low lying area and Block OD		Volume = 111500 m³ Foot Print Area = 2.1 ha Height = 2.7m Length = 10m Breadth = 10m	S26°10'52.9" E28°43'51.6"
Plant reuse raw water dam compartment 2 – collects contaminated water from the witklip evaporation dam, mobile pit water tank, washbay low lying area and Block OD		Volume = 51000 m³ Foot Print Area = 2.2 ha Height = 2.6m Length = 10m Breadth = 10m	S26°10'48.9" E28°43'51.0"
Washbay Low lying area – the low lying area collects clear water from the oil separator at the workshop & washbay as well as runoff from the washbay for reuse at the washbay or its pumped to the plant raw water dams - unlined		Volume =	S26°10'55.4"

Water Uses	Areas	Storage Volumes	Co-ordinates
		55000 m³	E28°44'16.0"
Mobile Pit Water Tank – this tank collects contaminated water pumped from the open pits and is pumped to the plant raw water dams – steel tank		Foot Print Area = 0.6 ha Height = 0.5m Length = 250m Breadth = 100m Volume = 3007 m³	S26°10'24.9" E28°44'30.0"
Process water storage Tank 3 – process water from the plant is stored in this tank – steel tank		Foot Print Area = 0.003 ha Height = 2 m Length = 6 m Breadth = 6 m Volume = 60 m³	S26°10'21.7" E28°43'51.0"
Process water storage Tank 4 - process water from the plant is stored in this tank – steel tank		Foot Print Area = 0.035 ha Height = 3 m Length = 0 m Breadth = 0 m Volume = 1050 m³	

Water Uses	Areas	Storage Volumes	Co-ordinates
			S26°10'21.7" E28°43'51.0"
Plant Raw Water Tank 1 – contaminated water from the plant raw water dams are stored in this dam for reuse – steel tank		Foot Print Area = 0.023 ha Height = 4.7 m Length = 0 m Breadth = 0 m Volume = 1081 m³	S26°10'21.7" E28°43'51.0"
Workshop Raw Water Tank – this tank stores contaminated water from the plant raw water dams for use at the wash bay – steel tank		Foot Print Area = 0.007 ha Height = 2.5 m Length = 0 m Breadth = 0 m Volume = 166 m³	S26°10'54.3" E28°44'18.8"
In-pit backfilling – disposal of plant discard from filter press and over burden into the open pits Foot print area>total area of property on which waste is disposed			
Low-lying area 1 - This was an internal catchment area that exists as a result of the location of the		Foot Print Area = 0.003 ha Height = 2.0 m Length = 0 m Breadth = 0 m Volume = 60	S26°10'19.7" E28°42'45.6"

Water Uses	Areas	Storage Volumes	Co-ordinates
infrastructure and the pits at blocks OH, OM and OD. Only clean runoff was contained in this area. The water surface area at full supply level is 9.50 hectares. But the area has in the mean time been cleaned up, and filled and compacted to be used as product stockpile area. This will be used to contain run-off water from product stockpile beds		m^3 Foot Print Area = 1 548 ha Height = 0 m Length = 0 m Breadth = 0 m Volume = 6 432 m^3/day Foot Print Area = 2.1 ha Height = 8 m Length = 100 m Breadth = 25 m Volume = 30 000 m^3/a	S26°10'21.7" E28°43'51.0"
Conservancy Tank 1 – linked to STP of 4 m^3 situated at plant offices	Leeuwpan 246 IR	10 m^3	S26°10'19.6" E28°43'47.4"
Conservancy Tank 2 - linked to STP of 4 m^3 situated at plant offices		10 m^3	S26°10'17.3" E28°43'49.3"
Conservancy Tank 3 - linked to STP of 4 m^3			

Water Uses	Areas	Storage Volumes	Co-ordinates
situated at plant offices		10 m³	S26°10'18.8" E28°43'50.7"
Conservancy Tank 6 - linked to STP of 4 m³ situated at plant offices		10 m³	S26°10'15.7" E28°43'41.1"
Conservancy Tank 7 – cleaned by Honey Sucker and disposed into STP of 4 m³ situated at plant offices		10 m³	S26°10'17.5" E28°43'39.9"
Conservancy Tank 8 – cleaned by Honey Sucker and disposed into STP of 4 m³ situated at plant offices		10 m³	S26°10'24.5" E28°43'40.7"
Conservancy Tank 16 – cleaned by Honey Sucker and disposed into STP of 4 m³ situated at plant offices		10 m³	S26°10'22.5" E28°43'40.6"
Conservancy Tank 19 – cleaned by Honey Sucker and disposed into STP of 4 m³ situated at plant offices		10 m³	S26°09'57.8" E28°43'47.8"
Package Sewage Treatment Plant		7 m³	S26°10'52.4" E28°44'22.2"
		4 m³	S28°95365" E26°92553"
Plant Pollution Control Dam – the dam collects runoff from the plant and the coal product stockpiles that is used for dust suppression – Lined dam, composite lining system		Ha coverage = 2.1 ha H = 1.7 m L = 200 m	S26°10'02.8" E28°43'28.5"

Water Uses	Areas	Storage Volumes	Co-ordinates
Load Out Evaporation Dam – Direct rainfall at the load-out station is collected and left out to evaporate – Not lined		B = 100 m V = 90 000 m³ Ha coverage = 0.5 ha H = 1.5 m L = 25 m B = 50 m	S26°09'49.2" E28°43'51.6"
Process water storage Tank 1 – Process water tank 1 stores process water used at the plant – Steel Tank			S26°10'15.6" E28°43'41.7"
Process water storage Tank 2 – Process water storage tank 2 stores process water to be used in the plant – Steel Tank		Intake water – 5328 and 20 000 m³ Ha coverage = 0.038 ha H = 3m Vol. Used 1140 m³	S26°10'15.6" E28°43'41.7"
Plant raw water Tank 2 – the tank stores contaminated water from the plant raw water dams for reuse at the plants – Steel tank		Intake water – 5328 and 20 000 m³ Ha coverage = 0.038 ha	S26°10'15.6" E28°43'41.7"

Water Uses	Areas	Storage Volumes	Co-ordinates
		H = 3m Vol. Used 1140 m³	
Jig thickener Dam – contains water from the Jig plant dirty water management system – Steel Dam		Intake water – 5328 and 20 000 m³ Ha coverage = 0.0063 ha H = 4.7m Vol. Used = 296 m³	S26°10'14.5" E28°43'41.6"
Jig Clarified Dam – contains water from the Jig plant water management system – steel dam		Ha coverage = 0.00263 ha H = 4.5m Vol. Used = 740 m³ Intake water –3 000 m³ Ha coverage = 0.00035 ha H = 4.5m Vol. Used = 160 m³	S26°10'14.5" E28°43'41.6"
Witklip return water dam (Reg. 24059135) – process water from the plant is stored in this return dam. Sized to accept seepage from the under drainage system and decant system for up to the 1:50 year rainfall event, over and above		Intake water 5328 (a) & 20 000 (j) Ha coverage	S26°10'23.5" E28°42'26.3"

Water Uses	Areas	Storage Volumes	Co-ordinates
normal operating conditions	Witklip 229 IR	= 50 ha H = 4 m L = 100 m B = 200 m Intake water 5328 (a) & 20 000 (j)	
Witklip Evaporation Dam – the dirty stormwater collected in this dam is left to evaporate – Lined with clay – application made with Dam Safety Office		Ha coverage = 3.3 ha H = 5.9 m L = 50 m B = 50 m	S26°10'23.5" E28°42'26.3"

3. QUALITY OF WASTE WATER TO BE DISPOSED

3.1 The quality of dirty water disposed off shall not exceed the following limits:

Table 3.1:

WATER QUALITY VARIABLES	UNITS	WATER QUALITY LIMITS
Conductivity	mS/m	40
Dissolved Oxygen	% Sat	70
pH	-	6.5-8.4
Alkalinity	mg $CaCO_3/\lambda$	120
Boron	mg/l	0.5
Calcium	mg/l	25
Chloride	mg/l	20
Fluoride	mg/l	0.5
Magnesium	mg/l	20
Potassium	mg/l	10

WATER QUALITY VARIABLES	UNITS	WATER QUALITY LIMITS
Sodium	mg/l	20
SAR	$meql^{0.5}$	1.0
Sulphate	mg/l	30
Total Dissolved Solids	mg/l	280
Dissolved Organic Carbon	mg/l	10
Oils and Greases	mg/l	5
Iron	mg/l	0.5
Manganese	mg/l	0.10
Aluminium	mg/l	0.02
Chrome (VI)	mg/l	0.05)
Ammonia*	mg/l as N	0.007
Nitrate	mg/l as N	6
Phosphate	mg/l as P	0.05
Total Phosphorus	mg/l as P	0.25
Total Inorganic Nitrogen	mg/l as N	2.5
E Coli	# per 100ml	50
Chlorophyll a	mg/l	0.02

4. MONITORING

4.1 The Licensee shall on monthly basis monitor Bronkhorstspruit at the upstream and downstream to determine the impact of the facility and other activities on the water quality by taking samples at the monitoring points.

4.2 The date, time and monitoring point in respect of each sample taken shall be recorded together with the results of the analysis.

4.3 Monitoring points shall not be changed prior to notification to and written approval by the Regional Head.

4.4 An Aquatic Scientist approved by the Regional Head must establish a monitoring programme for the following indices: Invertebrate Habitat Assessment System (IHAS) and the latest SASS (South African Scoring System). Sampling must be done once during the summer season and once during the winter season, annually, to reflect the status of the river upstream and downstream of the mining activities.

4.5 Water Quality testing to be performed on the pollution control dam(s) and the emergency surface pan on a quarterly basis in order to determine the risks to the

receiving environment. The data gathered in the investigation must be reported annually during March of each year to the Regional Head. If any water quality concentration level as specified is exceeded, the licensee must institute an investigation to determine the cause of poor quality.

4.6 Water Quality testing must be conducted quarterly on the wastewater stream from the pollution control dam(s) and the emergency surface pan when returned back to the mine for use as process water.

4.7 The licensee shall participate in any initiative such as Direct Estimation of Ecological Effect Potential (DEEEP) to determine the toxicity of complex tailings waste discharges. Both acute and chronic toxicity must be addressed and at least three taxonomic groups must be present when toxicity tests are performed.

4.8 Analysis shall be carried out in accordance with methods prescribed by and obtainable from the South African National Standards (SANS), in terms of the Standards Act, 1982 (Act 30 of 1982).

4.9 The methods of analysis shall not be changed without prior notification to and written approval by the Minister.

5. WATER RESOURCE PROTECTION

5.1 The impact of the activities of the mine on the Bronkhorspruit and its tributaries shall not exceed the following water quality limits as stipulated in Table 5.1:

Table 5.1

WATER QUALITY VARIABLES	UNITS	WATER QUALITY LIMITS
Conductivity	mS/m	35
Dissolved Oxygen	% Sat	70
pH	-	6.5-8.4
Alkalinity	mg $CaCO_3/\lambda$	120
Boron	mg/l	0.5
Calcium	mg/l	25
Chloride	mg/l	20
Fluoride	mg/l	0.5
Magnesium	mg/l	20
Potassium	mg/l	10
Sodium	mg/l	20

WATER QUALITY VARIABLES	UNITS	WATER QUALITY LIMITS
SAR	$meql^{0.5}$	1.0
Sulphate	mg/l	30
Total Dissolved Solids	mg/l	280
Dissolved Organic Carbon	mg/l	10
Oils and Greases	mg/l	5
Iron	mg/l	0.5
Manganese	mg/l	0.18
Aluminium	mg/l	0.02
Chrome (VI)	mg/l	0.05
Ammonia*	mg/l as N	0.007
Nitrate	mg/l as N	6
Phosphate	mg/l as P	0.05
Total Phosphorus	mg/l as P	0.25
Total Inorganic Nitrogen	mg/l as N	2.5
E Coli	# per 100ml	50
Chlorophyll a	mg/l	0.02

6. REPORTING

6.1 The Licensee shall update the water balance annually and calculate the loads of waste emanating from the activities. The Licensee shall determine the contribution of their activities to the mass balance for the water resource and must furthermore co-operate with other water users in the catchment to determine the mass balance for the water resource reserve compliance point.

6.2 The Licensee shall submit the results of analysis for the monitoring requirements to the Regional Head on a monthly basis under Reference number 16/2/7/B100/C27

7. STORM WATER MANAGEMENT

7.1 Storm water leaving the licensee's premises shall in no way be contaminated by any substance, whether such substance is a solid, liquid, vapour or gas or a combination thereof which is produced, used, stored, dumped or spilled on the premises.

7.2 Increase runoff due to vegetation clearance and/or soil compaction must be managed, and steps must be taken to ensure that storm water does not lead to bank instability and excessive levels of silt entering the stream.

7.3 Storm-water shall be diverted from the mine complex site and roads shall be managed in such a manner as to disperse runoff and concentrating the storm-water flow.

7.4 Where necessary works must be constructed to attenuate the velocity of any storm-water discharge and to protect the banks of the affected watercourses.

7.5 Storm-water control works must be constructed, operated and maintained in a sustainable manner throughout the impacted area.

7.6 Increased runoff due to vegetation clearance and/or soil compaction must be managed, and steps must be taken to ensure that storm-water does not lead to bank instability and excessive levels of silt entering the streams.

7.7 All storm-water that would naturally run across the pollution areas shall be diverted via channels and trapezoidal drains designed to contain the 1:50 year flood.

7.8 The polluted storm water system shall be designed and implemented to provide suitable routing and pumping capacity for contaminated storm water from the individual facilities to the respective storm water dams in accordance with the design specifications as contained in the Detailed Storm water management design and plan for the mine compiled by Greene Consultants

7.9 The polluted storm water captured in the storm water control dams shall be pumped to the process water treatment plant for reuse and recycling.

8. PLANT AREAS AND CONVEYANCES

8.1 Pollution caused by spills from the conveyances must be prevented through proper maintenance and effective protective measures especially near all stream crossings.

8.2 All reagent storage tanks and reaction units must be supplied with a bunded area built to the capacity of the facility and provided with sumps and pumps to return the spilled material back into the system. The system shall be maintained in a state of good repair and standby pumps must be provided.

8.3 Any hazardous substances must be handled according to the relevant legislation relating to the transport, storage and use of the substance.

8.4 Any access roads or temporary crossings must be:

05/04 2011 12:59 FAX 041

8.4.1 non-erosive, structurally stable and shall not induce any flooding or safety hazard; and
8.4.2 be repaired immediately to prevent further damage

9. ACCESS CONTROL

9.1 Strict access procedures must be followed in order to gain access to the property. Access to the discard dump and septic tank must be limited to authorised employees of the licensee and their Contractors only.

9.2 Notices prohibiting unauthorised persons from entering the areas referred to in condition 9.1, as well as internationally acceptable signs indicating the risks involved in case of an unauthorised entry must be displayed along the boundary fence of these areas.

10. CONTINGENCIES

10.1 Accurate and up-to-date records shall be kept of all system malfunctions resulting in non-compliance with the requirements of this licence. The records shall be available for inspection by the Regional Head upon request. Such malfunctions shall be tabulated under the following headings with a full explanation of all the contributory circumstances:

10.1.1 operating errors;
10.1.2 mechanical failures (including design, installation or maintenance);
10.1.3 environmental factors (e.g. flood);
10.1.4 loss of supply services (e.g. power failure); and
10.1.5 other causes.

10.2 The Licensee must, within 24 hours, notify the Regional Head of the occurrence or potential occurrence of any incident which has the potential to cause, or has caused water pollution, pollution of the environment, health risks or which is a contravention of the licence conditions.

10.3 The Licensee must, within 14 days, or a shorter period of time, as specified by the Regional Head, from the occurrence or detection of any incident referred above, submit an action plan, which must include a detailed time schedule, to the satisfaction of the Regional Head of measures taken to: –

10.3.1 correct the impacts resulting from the incident;
10.3.2 prevent the incident from causing any further impacts; and
10.3.3 prevent a recurrence of a similar incident.

05/04 2011 12:59 FAX 042

11. INTEGRATED WATER AND WASTE MANAGEMENT

11.1 The Licensee must prepare an *Integrated Water and Waste Management Plan (IWWMP)*, which must together with the *Rehabilitation Strategy* and *Implementation Programme (RSIP)*, be submitted to the Regional Head for approval within one (1) year from the date of issuance of this licence.

11.2 The IWWMP and RSIP shall thereafter be updated and annually submitted to the Regional Head for approval.

11.3 The licensee must, at least 180 days prior to the intended closure of any facility, or any portion thereof, notify the Regional Head of such intention and submit any final amendments to the IWWMP and RSIP as well as a final *Closure Plan*, for approval.

11.4 The licensee shall make full financial provision for all investigations, designs, construction, operation and maintenance for a water treatment plant should it become a requirement as a long-term water management strategy.

11.5 The licensee shall improve the current average daily water and salt balance on yearly basis and submit the report together with the IWWMP to the Regional Head.

11.6 The licensee shall conduct the geochemical assessment on plant discard from filter press before disposal to the open pits. The geochemical assessment report together with the IWWMP shall be submitted to the Regional Head.

11.7 The licensee shall prevent and minimise the generation of acid mine drainage throughout the mine life cycle.

05/04 2011 12:59 FAX 043

APPENDIX V

Section 21 (j) of the Act: Removing of water found underground

1. This licence authorises to removal of a total volume as follows:-

Table 1:

Water Uses	Areas	Volumes Dewatered	Co-ordinates
Block OD open pit	Kenbar 257 IR	24 000 m³/a	S26°10'41.6" E28°43'26.3"
Block OM & OH pit Dewatering		26 400m³/a	S26°10'41.6" E28°44'58.4"
Block OJ open pit dewatering	Moabsvelden 248 IR	15 360 m³/a	S26°09'49.2" E28°45'45.2"
Block OWM open pit dewatering		32 880 m³/a	S26°08'36.5" E28°46'49.5"
Witklip open pit – water is removed and stored	Witklip 229 IR	20 000 m³/a	S26°10'06.4" E28°42'19.3"

2. The quantity of the water authorised to be removed and disposed of into the pollution control dam in terms of this licence may not be exceeded without prior authorisation by the Minister

3. The quality of the water disposed into the pollution control dam shall not exceed the quality as specified in the Table 3 below

Table 3:

Variable	Average concentration	Maximum concentration
pH	6.5-9.0	6.5 – 9.0
Aluminium (mg/l)	0.05	0.15
Sulphate (mg/l)	291	200

05/04 2011 12:59 FAX 044

Variable	Average concentration	Maximum concentration
Iron(mg/l)	0.95	0.1

5. The Licensee shall provide any water user whose water supply is impacted by the water use with potable water.

6. The quantity of water removed from underground must be metered and recorded on a daily basis.

7. The groundwater levels shall be monitored every six months (once in the beginning of the dry season and once in the beginning of the wet season).

8. Self registering flow meters must be installed in the delivery lines at easily accessible positions near the dewatering points.

9. The flow metering devices shall be maintained in a sound state of repair and calibrated by a competent person at intervals of not more than once in two years. Calibration certificates shall be available for inspection by the Regional Head or his/her representative upon request.

10. Calibration certificates in respect of the pumps must be submitted to the Regional Head after installation thereof and thereafter at intervals of two years.

11. The date and time of monitoring in respect of each sample taken shall be recorded together with the results of the analysis.

12. Analysis shall be carried out in accordance with methods prescribed by and obtainable from the South African Bureau of Standards, in terms of the Standards Act, 1982 (Act 30 of 1982).

13. The methods of analysis shall not be changed without prior notification to the licensee and written approval by the Minister or his/her delegated nominee.

14. The Regional Head must be informed of any incident that may lead to underground water being disposed of contrary to the provisions of this licence, by submitting a report containing the following information: -

    14.1 nature of the incident (e.g. operating malfunctions, mechanical failures, environmental factors, loss of supply services, etc);

    14.2 actions taken to rectify the situation and to prevent pollution or any other damage to the environment; and

    14.3 measures to be taken to prevent re-occurrence of any similar incident.

15. The Licensee shall follow acceptable construction, maintenance and operational practices to ensure the consistent, effective and safe performance of the underground water removal system.

16. Reasonable measures must be taken to provide for mechanical, electrical or operational failures and malfunctions of the underground water removal system.

END OF LICENCE

05/04 2011 13:00 FAX 045

water & sanitation

Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

Private Bag X313, Pretoria, 0001, Sedibeng Building, 185 Francis Baard Street, Pretoria, Tel: (012) 336-7500, Fax: (012) 326-4472/ (012) 326-2715

AMENDEMENT IN TERMS OF SECTION 50 AND SECTION 158 NATIONAL WATER ACT, 1998 (ACT NO 36 OF 1998) (THE ACT)

I, ***Margaret-Ann Diedricks*** , in my capacity as Director-General in the Department of Water and Sanitation acting under authority of the powers delegated to me by the Minister of Water and Sanitation, hereby authorise he amendment of licence dated 24 June 2011, licence no . **04/B21A/ABCGIJ/429** and file no 25 March 2011.

SIGNED: _____

DATE: 18 December 2018

LICENCE NO: 04/B21A/ABCGIJ/429

FILE NO: 16/2/7/B100/C27

1.	**Licensee:**	**Exxaro Coal (Pty) Ltd: Leeuwpan Coal Mine**
	Postal address:	P.O Box 2353 Delmas 2210

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ANNEXURE II

Section 21(a) of the Act: Taking of water from a water resource
Deletion and replacement of conditions in table 1

Table 1

Water Uses	Volumes	Area	Co-ordinates
Taking water from a borehole	68 400m^3	Kenbar 257 IR	26°55'07.7"S E 29^{0}36"04.0"
Abstraction of waste water from block OD	226 992m^3/a	Kenbar 257 IR	S 26° 10' 41.6" E 28° 43' 26.3"
Abstraction of wastewater from block OM.	20 000m^3/a	Kenbar 257 IR	S 26° 10" 24.2" E 28^O 44" 58,4"
Abstraction of wastewater from block OH.	26 400	Kenbar 257 IR	S 26° 10" 24.2" E 28^O 44" 58,4"
Abstraction of wastewater from block OJ.	292 000	Moabsvelden 248 IR	S 26° 09" 49.2" E 28^O 45' 45.2"
Abstraction of wastewater from block OWM	31 880	Moabsvelden 248 IR	S 26° 09' 49.2" E 28° 46' 45.2"

ANNEXURE IV

Section 21(c) of the Act: Impeding or diverting the flow of water in a watercourse; Section 21(i) of the Act: Altering the bed, banks, course or characteristic of a watercourse

Deletion and replacement of condition 1.1

Water Uses	Area	Dimensions	Co-ordinates
Block OWM River diversion – Weltevreden tributary of the Bronkhorstspruit:	Moabsvelden 248 IR Weltevreden 227 IR		

ANNEXURE V

Section 21(g) of the Act: Disposing of waste in a manner which may detrimentally impact on a water resource

Deletion and replacement of condition 3.1

3. Quality of water to be disposed

3.1 The quality of the waste water shall not exceed the following limits:

Table 3.1

Parameters/ Substances	Limit
pH	5 – 10
Electrical Conductivity (EC) (mS/m)	750
Total Dissolved Solids (TDS) in mg/l	3800
Sodium (Na) in mg/l	500
Magnesium (mg/l) in mg/l	300
Aluminium (Al)in mg/l	10
Chloride (Cl) in mg/l	500
Sulphate (SO_4) in mg/l	3200
Potassium (k) in mg/l	40
Fluoride (F) in mg/l	5
Iron (Fe) in mg/l	20
Dissolved Organic carbon (mg/l)	100
Oils and Grease (mg/l)	1000
Manganese (mg/l)	10
Chrome (mg/l)	5
Ammonia (mg/l)	10
Nitrate (mg/l)	20
Phosphate (mg/l)	10
Total Phosphorus (mg/l)	20
Total Inorganic Nitrogen (mg/l)	15
E Coli # per 100 ml	<10
Chlorophyll a (mg/l)	0.15

APPENDIX V

Section 21 (j) of the Act: **Removing, discharging or disposing of water found underground if it is necessary for the effective continuation of an activity or for the safety of people**

Water Uses	Volumes	Area	Co-ordinates
Abstraction of waste water from block OD	226 992m^3/a	Kenbar 257 IR	S 26° 10' 41.6" E 28° 43' 26.3"
Abstraction of wastewater from block OM.	20 000m^3/a	Kenbar 257 IR	S 26° 10" 24.2" E 28° 44" 58,4"
Abstraction of wastewater from block OH.	26 400	Kenbar 257 IR	S 26° 10" 24.2" E 28° 44" 58,4"
Abstraction of wastewater from block OJ.	292 000	Moabsvelden 248 IR	S 26° 09" 49.2" E 28° 45' 45.2"
Abstraction of wastewater from block OWM	31 880	Moabsvelden 248 IR	S 26° 09' 49.2" E 28° 46' 45.2"

water & sanitation
Department:
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

Private Bag X313, Pretoria, 0001, Sedibeng Building Centre, 185 Francis Baard Street, Pretoria,
Tel: (012) 336-7500, Fax: (012) 326-4472/ (012) 326-2715

LICENCE IN TERMS OF SECTION 40 OF THE NATIONAL WATER ACT, 1998 (ACT NO 36 OF 1998) (THE ACT)

I, ***Margaret-Ann Diedricks,*** in my capacity as Director General in the Department of Water and Sanitation and acting under authority of the powers delegated to me by the Minister of Water and Sanitation, hereby authorises the following water uses in respect of this licence.

SIGNED: _____

DATE: 18 DECEMBER 2015

LICENCE NO: 04/B20A/CIJ/4032

FILE NO: 16/2/7/B100/C27

1.	**Licensee:**	**Exxaro Coal (Pty) Ltd: Leeuwpan Coal Mine OI and OL Expansion**
	Postal address:	P.O Box 2353 **Delmas** 2210

2. Water uses

2.1	Section 21 (a) of the Act:	Taking of water from a water resource Appendices I and II
2.2	Section 21(c) of the Act:	Impeding or diverting the flow of water in a watercourse subject to the conditions set out in Appendices I and III.

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2.3 Section 21(g) of the Act: Disposing of waste in a manner which may detrimentally impact on a water resource, subject to the conditions as set out in Appendices I and IV.

2.4 Section 21(i) of the Act: Altering the bed, banks, course or characteristics of a watercourse subject to the conditions set out in appendices I and Appendices III.

2.5 Section 21(j) of the Act: Removing, discharging or disposing of water found underground if it is necessary for the effective continuation of an activity or for the safety of people, subject to the conditions set out in Appendices I and V.

3. Table 1: Properties in respect of which this licence is issued

Farm	Title Deed	Owner
Moabsvelden 248 ptn 2 & 3	T24800002 & T24800003	Exxaro Leeuwpan (Pty) Ltd
Rietkuil 257 portion 2 & 10	T25700002 & T25700001	Hannes Potgieter Trustfonds

5. Licence and Review Period

This licence is valid for a period of twenty (20) years from the date of issuance and it may be reviewed at the time interval of not more than every five (5) years.

6. Definitions

"Any terms, words and expressions as defined in the National Water Act, 1998 (Act 36 of 1998) shall bear the same meaning when used in this licence."

"The Provincial Head"Provincial Chief Director: Mpumalanga, Department of Water and Sanitation, Private Bag X11259, MBOMBELA, 1200.

"Department" means Department of Water and Sanitation.

"Report" refers to the reports, Files 1 to 3 of Exxaro Coal (PTY) LTD: Exxaro Leeuwpan Coal Mine; Integrated Water Use License Application (IWULA) dated 26 August 2015 for Leeuwpan Block OI Expansion project which includes the main application, application forms and other supporting documentation and the

subsequent updated documents, designs and water balances, as well as all other related documentations and communications (emails, verbal, etc.).

7. Description of the activity

Exxaro Coal (Pty) Ltd is licensed for Section 21 (a), (c), (g), (f), (c) and (j) water uses as in accordance with Section 40 of the National Water Act, 1998 (Act 36 of 1998), to operate a coal mining and associated activities at Leeuwpan Coal in Delmas.

Exxaro Coal (Pty) Ltd: Leeupan Coal applied for a water use license in terms of Section 40 of the National Water Act, 1998 (Act 36 of 1998) for the for Pit dewatering, Mining through wetland, new plant and associated infrastructure located within 500m of wetland, raw water dam, return water dam, stockpile, dirty water dam, discard backfilling, silt trap and dust suppression. This infrastructure expansion is to ensure adequate supply for Leeuwpan Coal Mine's customers, including Eskom Holdings Limited (Eskom).

The proposed coal mining and associated activities are located within quaternary catchment, B20A in the Mpumalanga Province.

APPENDIX I

General conditions for the licence

1. This licence is subject to all applicable provisions of the National Water Act, 1998 (Act 36 of 1998).

2. The responsibility for complying with the provisions of the licence is vested in the Licensee and not any other person or body.

3. The Licensee must immediately inform the Provincial Head of any change of name, address, premises and/or legal status.

4. If the property in respect of which this licence is issued is subdivided or consolidated, the Licensee must provide full details of all changes in respect of the properties to the Provincial Head of the Department within 60 days of the said change taking place.

5. If a water user association is established in the area to manage the resource, membership of the Licensee to this association is compulsory. Rules, regulations and water management stipulation of such association must be adhered to.

6. While effect must be given to the Reserve as determined in terms of the Act, where a desktop determination of the Reserve has been used in issuance of a licence, when a comprehensive determination of the Reserve has finally been made; it shall be given effect to.

7. The licence shall not be construed as exempting the Licensee from compliance with the provisions any other applicable Act, Ordinance, Regulation or By-law.

8. The licence and amendment of this licence are also subject to all the applicable procedural requirements and other applicable provisions of the Act, as amended from time to time.

9. The Licensee shall conduct an annual internal audit on compliance with the conditions of licence. A report on the audit shall be submitted to the Provincial Head within one month of the finalisation of the audit.

10. The Licensee shall appoint an independent external auditor to conduct an annual audit on compliance with the conditions of this licence.

11. Any incident that causes or may cause water pollution shall be reported to the Provincial Head or his/her designated representative within 24 hours.

12. If the water use described in this licence is not exercised within 3 years of the date of the licence, the authorization will be withdrawn. Upon commencement of the water use, the Licensee must inform the relevant authority in writing.

13. The Licensee shall establish and implement a continual process of raising awareness amongst itself, its workers and stakeholders for the need for Water Conservation/Water Demand Management.

14. Notices prohibiting unauthorized persons from entering water use premises must be displayed.

15. The Department accepts no liability for any damage, loss or inconvenience of whatever nature, suffered as a result of/ amongst other things.

    15.1 Any force majeur event;
    15.2 Siltation of the river or dam basin; and
    15.3 Required Reserve releases.

APPENDIX II

Section 21(a) of the Act: Taking water from a water resource

1. This licence authorises the taking of water in cubic metres per annum (m^3/a) in properties as indicated in Table 1 below:

Table 1: Taking of water from the pits

Water use(s)	Purpose	Capacity/ Volume (m3, tonnes and/or m3/annum)	Property Description	Co-ordinates
Section 21(a)				
Pit OI Dewatering	Abstraction of water from the proposed new Block OI to the Raw Water Dam	72 000 m^3/annum total for OI	Moabsvelden 248IR Portion 2 and 16	26° 10' 41.470" S 28° 45' 10.920" E

2. The quantity of water authorised to be taken in terms of this licence may not be exceeded without prior authorisation by the Minister.

3. This licence does not imply any guarantee that the said quantities and qualities of water will be available at present or at any time in the future.

4. The above-mentioned volume may be reduced when this licence is reviewed.

5. The Licensee shall continually investigate new and emerging technologies and put into practice water efficient devices or apply technique for the re-use of water containing waste, in an endeavour to conserve water at all times.

6. All water taken from the resource shall be measured as follows:

6.1 The daily quantity of water taken must be metered or gauged and the total recorded at the last day of each month; and

6.2 The Licensee shall keep record of all water taken and a copy of the records shall be forwarded to the Regional Head on or before 25 January and 25 July of each year.

7. No water taken may be pumped, stored, diverted, or alienated for purposes other than intended in this licence, without written approval by the Minister or his/her delegated nominee.

8. The Licensee shall install and monitor appropriate water measuring to measure the amount of water abstracted, received and/or consumed, as applicable to the infrastructure.

9. Notices prohibiting unauthorised persons from entering certain areas, as well as internationally acceptable signs indicating the risks involved in case of an unauthorised entry must be displayed along the boundary fence of these areas.

10. The Department accepts no liability for any damage, loss or inconvenience, of whatever nature, suffered as a result of-

10.1 shortage of water;

10.2 inundations or flood;

10.3 siltation of the resource; and

10.4 required reserve releases.

11. The Licensee shall ensure that all measuring devices are properly maintained and in good working order and must be easily accessible. This shall include a programme of checking, calibration, and/or renewal of measuring devices.

12. The Licensee shall establish a programme of formal Information Management System, which maintains a database on water supply, distribution and delivery infrastructure.

13. The Licensee shall establish and implement a continual process of raising awareness amongst itself, its workers and stakeholders for the need to for Water Conservation and Water Demand Management.

APPENDIX III

Section 21 (c) of the Act: **Impeding or diverting the flow of water in a watercourse**

Section 21 (i) of the Act: **Altering the bed, banks, course or characteristic of a watercourse**

1. CONSTRUCTION, OPERATION AND MAINTENANCE

1.1 The licence authorises the following section 21 (c) and (i) water use activities as set out in Table 2 below and in the water use application reports submitted to the Department:

Table 2: Section 21 (c) and (i) water use activities

Water use(s)	**Purpose**	**Capacity/ Volume (m3, tonnes and/or m3/annum)**	**Property Description**	**Co-ordinates**
Section 21 c & i				
Activity	Purpose	Affected Watercourse	Property	Co-ordinates
Open Pit OL	Open Pit 1 will be mining through a Wetland	Bronkhorstspruit	MOABSVELDEN 248 IR	26° 10' 56.932" S 28° 45' 32.971" E
Open Pit OI	Open Pit 1 will be mining through a Wetland	Bronkhorstspruit	RIEKKUIL 249 IR	26° 10' 56.932" S 28° 45' 7.258" E
New Plant and Infrastructure	Proposed new plant and the associated infrastructure will be located and operated	Bronkhorstspruit	KENBAR 257 IR	26° 11' 3.442" S 28° 44' 22.714" E

Water use(s)	Purpose	Capacity/ Volume (m3, tonnes and/or m3/annum)	Property Description	Co-ordinates
	within 500m from a wetland area.			

1.2 No activity must take place within the 1:100 year flood line or the delineated riparian habitat, whichever is the greatest, or within 500 m radius from the boundary of any wetland unless authorised by this licence.

1.3 The conditions of the authorisation must be brought to the attention of all persons (employees, sub-consultants, contractors etc.) associated with the undertaking of these activities and the Licensee must take such measures that are necessary to bind such persons to the conditions of this licence.

1.4 A suitably qualified person(s), appointed by the Licensee, and approved in writing by the Provincial Head must be responsible for ensuring that the activities are undertaken in compliance with the specifications as set out in reports submitted to the Department or the Responsible Authority and the conditions of this licence.

2 FURTHER STUDIES AND INFORMATION REQUIREMENTS

2.1 If the Licensee is not the end user/beneficiary of the water use related infrastructure and will not be responsible for long term maintenance and management of the infrastructure, the Licensee must provide a programme for hand over to the successor-in-title including a brief management/maintenance plan and the agreement for infrastructure along with allocation of responsibilities, within three (3) months of the date of issuing of this licence.

2.2 For all the activities listed under condition 1.1, Table 2, "as-built" plan(s) and engineering drawing(s) prepared by a registered professional engineer, must be submitted to the Provincial Head within two (2) months of the date of issuance of this licence. These plan(s) and drawing(s) must indicate the watercourse(s) including wetland boundaries and layout and structure location(s) of all infrastructure impeding and/or diverting flow of watercourses as well as alterations to watercourse(s) on the properties.

3 PROTECTIVE MEASURES

3.1 Storm Water Management

3.1.1 Storm water management practices must be constructed, operated and maintained in a sustainable manner throughout the project and for the water use activities set out in condition 1.1 Appendix III and must include but are not limited to the following;

3.1.2 Increased runoff due to vegetation clearance and/or soil compaction must be managed, and steps must be taken to ensure that storm water does not lead to bank instability and excessive levels of silt entering the watercourse(s);

3.1.3 Storm water must be diverted from mining areas, stockpiles, infrastructure areas and roads and must be managed in such a manner as to disperse runoff and to prevent the concentration of storm water flow;

3.1.4 The velocity of storm water discharges must be attenuated and the banks of the watercourses protected, notably in this environment of dispersive soils;

3.1.5 Storm water leaving the Licensee's premises must in no way be contaminated by any substance, whether such substance is a solid, liquid, vapour or gas or a combination thereof which is produced, used, stored, dumped or spilled on the premises;

3.1.6 Sheet runoff from paved, hardened surfaces and access roads need to be curtailed.

3.2 Structures and Materials

3.2.1 The necessary erosion prevention measures must be employed to ensure the sustainability of all structures.

3.2.2 The height, width and length of structures must be limited to the minimum dimension necessary to accomplish the intended function.

3.2.3 Structures must not be damaged by floods exceeding the magnitude of floods occurring on average once in every 100 years.

3.2.4 Structures must be non-erosive, structurally stable and must not induce any flooding or safety hazard.

3.2.5 Structures must be inspected regularly for accumulation of debris, blockage, erosion of abutments and overflow areas - debris must be removed and damages must be repaired and reinforced immediately.

3.2.6 All areas affected by construction must be rehabilitated upon completion of the construction phase of the development. Areas should be reseeded with indigenous vegetation species as required, and the use of seednets is recommended to prevent erosion.

3.2.7 Any access roads or crossings should be:

3.2.7.1 Non-erosive, structurally stable and should not induce any flooding or safety hazard;

3.2.7.2 Any damage is repaired immediately to prevent further damage;

3.2.7.3 Non-polluting with respect to silt and litter that can be deposited into a watercourse;

3.2.7.4 Watercourse crossings to facilitate the movement of aquatic and non-aquatic organisms and fauna;

3.2.7.5 Crossing surfaces must be tarred or concreted along the extent of the watercourse and extent at least 100m beyond the extent of the watercourse to minimize impacts on the characteristics of the watercourse;

3.2.7.6 Where any road is within the 100m buffer zone of the watercourse, this portion of the road shall be concreted or tarred; and

3.2.7.7 Not consist of any sulphur containing and/or other polluting material.

3.3 Water Quality

3.3.1 The Licensee shall sample the water quality monthly at monitoring points both upstream and downstream of the activities and report to the Responsible Authority within six (6) month after the results of each sampling event is received:

Table 3: Surface Water quality parameters relevant for sampling

Variable
pH
Electrical conductivity (EC) (mS/m)
Suspended solids (SS) (mg/ℓ)
Turbidity (NTU)
Alkalinity (mg $CaCO_3$/ℓ)
Sodium (Na) (mg/ℓ)
Iron (Fe) (mg/ℓ)

Manganese (Mn) (mg/ℓ)
Aluminium (Al) (mg/ℓ)
Ammonia (NH_3) (mg/ℓ)
Sulphate (SO_4) (mg/ℓ)

3.3.2 Monitoring must continue for three (3) years after the cessation of the activities listed in condition 1.1 Appendix III.

3.3.3 Monitoring must be undertaken as set out in Section 5 Appendix III.

3.3.4 Activities that lead to elevated levels of turbidity of any watercourse(s) must be prevented, reduced, or otherwise remediated. Activities must be scheduled to take place during the dry seasons when flows are lowest where reasonably possible. If this is not possible and if management measures have not been provided for in the reports submitted to the Responsible Authority, the Licensee must submit such to the Responsible Authority for written approval before these activities commence. Natural in stream hydrology is to be used to determine which months constitute the low flow months.

3.3.5 The Licensee must ensure that the quality of the water to downstream water users does not decrease because of the water use activities listed under condition 1.1.

3.3.6 A qualified person must be appointed to assess the quality of water both upstream and downstream of the activities prior to commencement of construction.

3.3.7 Pollution of and disposal/spillage of any material into the watercourse must be prevented, reduced, or otherwise remediated through proper operation, maintenance and effective protective measures.

3.3.8 Vehicles and other machinery must be serviced well above the 1:100 year flood line or delineated riparian habitat, whichever is the greatest. Oils and other potential pollutants must be disposed off at an appropriate licensed site, with the necessary agreement from the owner of such a site.

3.3.9 Any hazardous substances must be handled according to the relevant legislation relating to transport, storage and use of the substance and all storage facilities must be equipped with large, clearly readable material safety data sheets (MSDS).

3.3.10 All reagent storage tanks and reaction units must be supplied with a bunded area built to cater for at least 110% of the capacity of the facility and provided with sumps and pumps return the spilled material back into the system. The system

must be maintained in a state of good repair and standby pumps must be provided.

3.3.11 The Licensee has to indicate to the Responsible Authority within sixty (60) days after issuance of this licence, the strategic placement of bio-swale, bio-filters, silt, litter and hydrocarbon (oil) traps to minimise the risk of pollutants entering the natural drainage system of the area. The submission must address also cleaning, maintenance and legal disposal of the contents of these traps. An oil recycling register must be in place to indicate that oils are recovered/ recycled above 20% from the monthly inventory for every oil storage unit.

3.3.12 Where any coal spills along the stream crossings and roads occur, they have to be cleaned immediately. Daily inspections are recommended and to be recorded formally. Coal spills into watercourses will be communicated to the Provincial Head within two (2) days after it occurred. The Licensee must take precautionary measures to prevent reoccurrence.

3.3.13 The Licensee shall sample and analyse twice a year (dry - July and wet – January season) all surface and groundwater monitoring points for a full spectrum of heavy metals and submit this information with condition 3.3.1 Appendix II.

3.3.14 Where dust suppression is practiced the following shall apply: Dust suppression activities shall not contaminate and/or pollute any watercourse and the Licensee must conduct six (6) monthly soil monitoring events to determine the impact of dust suppression on the receiving environment. Soil samples shall at least be analysed for pH, Electrical Conductivity (mS/m), Calcium (Ca) (mg/l), Magnesium (Mg) (mg/l), Potassium (K) (mg/l), Sodium (Na) (mg/l), Chloride (Cl) (mg/l), Sulphate (SO_4) (mg/l), Aluminium (Al) (mg/l), Iron (Fe) (mg/l), Manganese (mg/l) and Nitrate (NO_3 as N) (mg/l). The soil monitoring program and reporting must be conducted by an independent, professional, qualified soil scientist and hydrologist. Soil samples to be compared with reference sites. The reporting is part of condition 3.3.1 Appendix III.

3.4 Flow

3.4.1 The Licensee must determine flood lines (1:50 and 1:100 year) prior to construction to ensure risks are adequately managed. Flood lines must be clearly indicated on the site plan(s) and drawings along with all wetland boundaries.

3.4.2 The activities must be conducted in a manner that does not negatively affect catchment yield, hydrology and hydraulics. The Licensee must ensure that the

overall magnitude and frequency of flow in the watercourse(s) does not decrease, other than for natural evaporative losses and authorised attenuation volumes.

3.4.3 Appropriate design and mitigation measures must be developed to minimise impacts on the natural flow regime of the watercourse i.e. through placement of structures/supports and to minimise turbulent flow in the watercourse.

3.4.4 Structures must be designed in a way to prevent the damming of stream/river water and not impact on the flow of the water, during the construction and operational phases of all developments.

3.4.5 The development may not impede natural drainage lines.

3.4.6 The diversion structures may not restrict river flows by reducing the overall river width or obstructing river flow.

3.4.7 The characteristics of the streambed are likely to be altered locally. In particular the rock and rubble created during the construction process is likely to have sharp edges, and not smooth surfaces that are typically associated with river rocks and pebbles. All rock and rubble must be removed from the watercourse once construction has been completed. Any rock placed in the watercourse to enhance the dissolved oxygen content of the water must adhere to the same criteria, namely only smooth rock surfaces to be placed within the watercourse.

3.5 Riparian and Instream Habitat (Vegetation and Morphology)

3.5.2 Activities (including spill clean-up) must start up-stream and proceed into a down-stream direction, so that the recovery processes can start immediately, without further disturbance from upstream works.

3.5.3 Operation and storage of equipment must not take place within the 1:100 year flood line or delineated riparian habitat, whichever is the greatest unless authorised in this licence.

3.5.4 Activities must not occur in sensitive riffle habitats.

3.5.5 Indigenous riparian vegetation, including dead trees, outside the limits of disturbance indicated in the site plans must not be removed from the area.

3.5.6 Alien and invader vegetation must not be allowed to further colonize the area, and all new alien vegetation recruitment must be sustainably eradicated or controlled.

3.5.7 Existing vegetation composition must be maintained or improved by maintaining the natural variability in flow fluctuations. Rehabilitated areas shall have vegetation basal cover of at least 15% at all times.

3.5.8 Recruitment and maintaining of a range of size classes of dominant riparian species in perennial channels must be stimulated.

3.5.9 Encroachment of additional exotic species and terrestrial species in riparian zones must be discouraged.

3.5.10 Accumulation of woody debris on terraces by periodic flooding must be discouraged.

3.5.11 Existing flood terraces and deposition of sediments on these terraces to ensure optimum growth, spread and recruitment of these species must be maintained.

3.5.12 The necessary erosion prevention mechanisms must be employed to ensure the sustainability of all structures and activities and to prevent instream sedimentation.

3.5.13 Soils that have become compacted through the water use activities must be loosened to an appropriate depth to allow seed germination.

3.5.14 Slope/bank stabilisation measures must be implemented with a 1:3 ratio or flatter and vegetated with indigenous vegetation immediately after the shaping.

3.5.15 Stockpiling of removed soil and sand must be stored outside of the 1:100 flood line or delineated riparian habitat, whichever is the greater, to prevent being washed into the river and must be covered to prevent wind and rain erosion.

3.5.17 The indiscriminate use of machinery within the in stream and riparian habitat will lead to compaction of soils and vegetation and must therefore be strictly controlled.

3.5.18 The overall macro-channel structures and mosaic of cobbles and gravels must be maintained by ensuring a balance (equilibrium) between sediment deposition and sediment conveyance maintained. A natural flooding and sedimentation regime must thus be ensured as far as reasonably possible.

3.5.19 As much indigenous vegetation growth as possible should be promoted within the proposed development area in order to protect soil and to reduce the percentage of the surface area which is paved.

3.5.20 Run-off from paved and hardened surfaces should be slowed down by the strategic placement of berms.

3.6 Biota

3.6.1 The Licensee must take all reasonable steps to allow movement of aquatic species, including migratory species.

3.6.2 All reasonable steps must be taken not to disturb the breeding, nesting and/or feeding habitats and natural movement patterns of aquatic biota.

3.6.3 The current level of diversity of biotopes and communities of animals, plants and microorganisms must be maintained.

3.6.4 The outcome of condition 3.3.13 must be assessed together with condition 5.2 Appendix III.

4 REHABILITATION AND MANAGEMENT

4.1 The Licensee must embark on a systematic long-term rehabilitation programme to restore the watercourse(s) to environmentally acceptable and sustainable conditions after completion of the activities, which must include, but not be limited to the rehabilitation of disturbed and degraded riparian areas to restore and upgrade the riparian habitat integrity to sustain a bio-diverse riparian ecosystem.

4.2 All disturbed areas must be re-vegetated with an indigenous seed mix in consultation with an indigenous plant expert, ensuring that during rehabilitation only indigenous shrubs, trees and grasses are used in restoring the biodiversity.

4.3 An active campaign for controlling invasive species must be implemented within disturbed zones to ensure that it does not become a conduit for the propagation and spread of invasive exotic plants.

4.4 Rehabilitation must be concurrent with construction.

4.5 Topsoil must be stripped and redistributed.

4.6 Compacted and disturbed areas must be shaped to natural forms and to follow the original contour. In general cut and fill slopes and other disturbed areas must not exceed 1:3 (v:h) ratio, it must be protected, vegetated, ripped and scarified parallel with the contour.

4.7 The Provincial Head will sign a release form indicating that rehabilitation was done satisfactory according to specifications as per this licence.

4.8 A photographic record must be kept as follows and submitted with reports as set out in section 5 Appendix III:

4.8.1 Dated photographs of all the sites to be impacted before construction commences;

4.8.2 Dated photographs of all the sites during construction on a monthly basis; and

4.8.3 Dated photographs of all the sites after completion of construction, seasonally.

4.9 Rehabilitation structures must be inspected regularly for the accumulation of debris, blockages instabilities and erosion with concomitant remedial and maintenance actions.

4.10 The original contours must be established over the stream crossings and roads. After the backfill has subsided, the contour must follow the surrounding contours to stop irregular flows or blockage of biotic movement.

4.11 A Wetland Management and Rehabilitation Plan must be compiled by a wetland specialist and submitted to the Regional Head for written approval.

5 MONITORING AND REPORTING

5.1 A comprehensive and appropriate environmental assessment and monitoring programme (including bio-monitoring, sediment sampling and ecotoxicology) to determine the impact, change, deterioration and improvement of the aquatic system associated with the activities listed under condition 1.1 Appendix III as well as compliance to these water use licence conditions must be developed and submitted to the Regional Head for written approval before commencement and must subsequently be implemented as directed. The monitoring programme shall be compared against the **REC (Recommended Ecological Class) of a C** within the Bronkhorstspruit River.

5.2 Six (6) monthly monitoring reports must be submitted to the Responsible Authority until otherwise agreed in writing with the Provincial Head.

5.3 A qualified and responsible scientist must be retained by the Licensee who must give effect to the various licence conditions and to ensure compliance thereof pertaining to all activities impeding and/or diverting flow of watercourses as well as alterations to watercourses on the properties as set out in condition 1.1.

5.4 The Licensee must conduct on an annual basis an internal audit on compliance with the conditions this licence. A report on the audit must be submitted to the Responsible Authority within one month of the finalisation of the audit. A qualified independent auditor must undertake this audit.

5.5 The audit reports must include but are not limited to:

5.5.1 Reporting in respect of the monitoring programme referred to in condition and all other reporting and compliance conditions outlined in this licence;

5.5.2 A record of implementation of all mitigation measures including a record of corrective actions; and

5.5.3 Compensation measures for damage where mitigation measures have failed to adequately protect the in-stream and riparian habitat or any other characteristic of the watercourses.

5.6 The Licensee must apply in writing to the Provincial Head for alternative reporting arrangements for which written approval must be provided.

5.7 A wetland specialist must be appointed to monitor the compliance to the wetland management and rehabilitation plan and conditions in this license pertaining to impacts on wetlands and provide specialist advice for corrective actions and compile audit reports which must be submitted to the Responsible Authority.

6 OTHER WATER USERS

6.1 The Licensee must attempt to prevent adverse affect on other water users. All complaints must be investigated by a suitable qualified person and if investigations prove that the Licensee has impaired the rights of other water users, the Licensee must initiate suitable compensative measures.

7. POLLUTION PREVENTION, INCIDENTS AND MALFUNCTIONS

7.1 Pollution incidents must be dealt with in accordance with Section 19 and 20 of the National Water Act.

7.2 Any incident that may cause pollution of any water resource must immediately be reported to the Responsible Authority.

7.3 If surface and/or groundwater pollution has occurred or may possibly occur, the Licensee must conduct, and/or appoint specialists to conduct the necessary investigations and implement additional monitoring, pollution prevention and remediation measures to the satisfaction of the Responsible Authority.

7.4 The Licensee shall keep all records relating to the compliance or non-compliance with the conditions of this licence in good order. Such records must be made available to the Responsible Authority within 14 (fourteen) days of receipt of a written request by the Department for such records.

7.5 The Licensee must keep an incident report and complaints register, which must be made available to any external auditors and the Department.

8 BUDGETARY PROVISIONS

8.1 The water user must ensure that there is a budget sufficient to complete and maintain the water use and for successful implementation of the rehabilitation programme as set out in this licence.

8.2 The Department may at any stage of the process request proof of budgetary provisions for rehabilitation and closure of project.

8.3 The Licensee is fully responsible and accountable for any negative impacts on the watercourse(s) and the modeling, monitoring and mitigation thereof, until such time that no negative impacts are experienced or foreseen.

8.4 The Licensee shall submit to the Provincial Head before the 31st of March annually or immediately in the case of condition 8.4.2:

8.4.1 Proof of annual public participation meetings on the conditions of this licence and (non)compliance to its conditions; and

8.4.2 Provide information on any unauthorized activities and the reasons therefore.

APPENDIX IV

Section 21(g) of the Act: Disposing of waste in a manner which may detrimentally impact on a water resource

1. CONSTRUCTION AND OPERATION

1.1 The Licensee shall carry out and complete all the activities, including the construction and operation of the Pollution Control Dam according to the Report and according to the final plans Technical Design Report as approved by the Provincial Head.

Table 3: Geographical positions of the waste water management facilities

Water use(s)	Purpose	Capacity/ Volume (m3, tonnes and/or m3/annum)	Property Description	Co-ordinates
Section 21(g)				
Raw Water Dam	Raw water from collection points will be stored in the raw water dam for use at the plant	28 931m3	KENBAR 257 IR	26° 10' 52.992" S 28° 43' 52.048" E
Process Water Dam	A process water dam will be required and be located on the Plant terrace next to the Storm water	10 116 m3	KENBAR 257 IR	26° 10' 56.282" S 28° 44' 26.069" E

Water use(s)	Purpose	Capacity/ Volume (m3, tonnes and/or m3/annum)	Property Description	Co-ordinates
	collection dam.			
Storm Water Dam	A storm water dam will be required to control run-off from the natural environment	9 721m^3	KENBAR 257 IR	26° 10' 57.732" S 28° 44' 27.287" E
Stockpile	Water control Measures at the stockpile areas.	2 341m^3	KENBAR 257 IR	26° 11' 2.249" S 28° 44' 24.339" E
Dirty water dam for stockyard	A dirty water dam to contain dirty water from the Stockyard	11 337.5m^3	KENBAR 257 IR	26° 11' 7.247" S 28° 44' 17.246" E
Discard Backfilling for Pit OI	Pit OI will be backfilled once mining is completed	250 000tons	MOABSVELDEN 248 IR	26° 10' 56.932" S 28° 45' 32.971" E
Discard Backfilling for	Pit OL will be backfilled	250 000tons	RIEKKUIL 249 IR	26° 10' 56.932" S

Water use(s)	Purpose	Capacity/ Volume (m3, tonnes and/or m3/annum)	Property Description	Co-ordinates
Pit OL	once mining is completed			28° 45' 7.258" E
Silt trap	The Storm water Dam will spill into the Silt trap	9 352m^3	KENBAR 257 IR	26° 10' 56.266" S 28° 44' 28.291" E
Dust suppression	Water for dust suppression of will be collected from the approved Plant PCD's	7650 m^3	Leeuwpan 246	28° 43' 28.5" S 26° 10' 02.8" E

1.2 The construction of the Pollution Control Dam must be carried out under the supervision of a professional Civil Engineer, registered under the Engineering Profession of South Africa Act, 1990 (Act 114 of 1990), as approved by the designer.

1.3 Within 30 days after the completion of the activities referred here in accordance with the relevant provisions of this licence, the Licensee shall in writing, under reference, 16/2/7/B100/C27, inform the Provincial Head thereof. This shall be accompanied by a signature of approval from the designer referred to above that the construction was done according to the design plans referred to in the Report.

1.4 The Licensee shall as well submit a set of as-built drawings to the Provincial Head after the completion of the Pollution Control Dam.

1.5 The Pollution Control Dam shall be operated and maintained to have a minimum freeboard of 0.8 metres above full supply level and all other water

systems related thereto shall be operated in such a manner that it is at all times capable of handling the 1:50 year flood-event on top of its mean operating level.

1.6 The Licensee shall use acknowledged methods for sampling and the date, time and sampler must be indicated for each sample.

1.7 Flow metering devices shall be maintained in a sound state of repair and calibrated by a competent person at intervals of not more than once in two years. Calibration certificates shall be available for inspection by the Provincial Head or his representative upon request.

2. STORAGE OF WATER CONTAINING WASTE

2.1 The Licensee is authorised to store water constianing waste in waste management facilities facilities listed in table 6

Table 4: Waste management facility (pollution control dam)

Facility	Properties	Total Volume (m^3/a)	Co-ordinates
Pollution Control Dam		729 708 m^3/a	S 26°17'42 6" E 29° 09' 23.7"

3. DUST SUPPRESSION

3.1 This Licence authorises the use of seven thousand six hundred and fifty cubic metres (m^3) of wastewater per annum from the pollution control dam for dust suppression on Moabsvelden 248IR Portion 2.

3.2 No excessive dust suppression that leads to saturated conditions and no dust suppression during wet periods.

3.3 An annual soil chemistry map must be compiled and submitted, with a report, to the Provincial Head. The soil chemistry map shall cover the areas covered by the dust suppression and map concentrations of pH, Electrical Conductivity and Sodium. This map must be interpreted by a professional soil scientist and recommendations and conclusions must be included in a report.

4. QUALITY OF WASTE WATER TO BE DISPOSED OF THE WASTE WASTER CONTAINMENT FACILITY

The quality of wastewater disposed of on the waste water containment facility shall not exceed the following limits as specified in Tables 5 below:

Table 5: Wastewater qualities to be disposed of the waste water containment facility

Variables	Measurement	Quality
pH	pH	5.0-9.5
Electircal Conductivity	mS/m	<150
Calcium	mg/L	-
Magnesium	mg/L	50.6
Sodium	mg/L	59.9
Chloride	mg/L	38.6
Sulphate	mg/L	400
Nitrate	mg/L	3
Fluoride	mg/L	0.44

5. MONITORING

5.1 Monitoring of waste water

5.1.1 The Licensee shall monitor the water quality of the treated water continuously with online water quality monitoring of the key variables as indicated in Table 7

5.2 Surface Water Quality

5.2.1 The Licensee shall submit within one month of the date of the issuance of the licence, a surface water quality monitoring programme, with the GPS co-ordinates and the criteria used in the selection of the water monitoring points.

5.2.2 The location of additional monitoring points, which may from time to time be specified by the Provincial Head, shall be communicated in writing to the Licensee and this communication shall be regarded as part of the licence.

5.2.3 Monitoring for quality shall only be carried out at the monitoring points listed below:

5.2.4 The following variables (constituents) shall be included in the surface monitoring programme

pH

Electrical Conductivity (EC)	mS/m
Chlorides (Cl)	mg/l
Sulphates (So4)	mg/l
Fluoride (F)	mg/l
Sodium (Na)	mg/l
Potassium (K)	mg/l
Calcium (Ca)	mg/l
Magnesium (Mg)	mg/l
Aluminium (Al)	mg/l
Iron (Fe)	mg/l
Manganese (Mn)	mg/l
Nitrate (NO_2)	mg/l
Iron (Fe)	mg/l
Total dissolved solids (TDS)	mg/l
Total hardness	mg/l

5.3 Groundwater Quality

5.3.1 The Licensee shall submit within one month of the date of the issuance of this licence, a ground water quality monitoring programme which must provide the detailed criteria followed in the establishment of the groundwater monitoring point.

6. STORM WATER MANAGEMENT

6.1 Storm water leaving the Licensee's premises shall in no way be contaminated by any substance, whether such substance is a solid, liquid, vapour or gas or a combination thereof which is produced, used, stored, dumped or spilled on the premises.

6.2 Increase runoff due to vegetation clearance and/or soil compaction must be managed, and steps must be taken to ensure that storm water does not lead to bank instability and excessive levels of silt entering the stream.

6.3 Storm water shall be diverted from the site and roads and shall be managed in such a manner as to disperse runoff and concentrating the storm-water flow.

6.4 Where necessary works must be constructed to attenuate the velocity of any storm-water discharge and to protect the banks of the affected watercourses.

6.5 Storm water control works must be constructed, operated and maintained in a sustainable manner throughout the impacted area.

7.6 Increased runoff due to vegetation clearance and/or soil compaction must be managed, and steps must be taken to ensure that storm water does not lead to bank instability and excessive levels of silt entering the streams.

7.7 All storm water that would naturally run across the pollution areas shall be diverted via channels and trapezoidal drains designed to contain the 1:50 year flood.

6.7 The polluted storm water system shall be designed and implemented to provide suitable routing and pumping capacity for contaminated storm water from the individual facilities to the respective storm water dams in accordance with the design specifications as contained in the Technical Design Report.

7. ACCESS CONTROL

7.1 Strict access procedures must be followed in order to gain access to the property. Access to the Pollution Control Dam must be limited to authorised employees of the Licensee and their Contractors only.

7.2 Notices prohibiting unauthorised persons from entering the areas referred to in condition 2.1 of Appendix III, as well as internationally acceptable signs indicating the risks involved in case of an unauthorised entry must be displayed along the boundary fence of these areas.

7.3 The Licensee must take all reasonable steps to maintain service roads in a condition which ensures unimpeded access to the mine residue facility for vehicles involved in closure

7.4 The Licensee must ensure that all entrance gates are manned during the hours of operation/closure construction and locked outside the hours of operational/closure construction.

8. CONTINGENCIES

8.1 Accurate and up-to-date records shall be kept of all system malfunctions resulting in non-compliance with the requirements of this licence. The records shall be available for inspection by the Provincial Head upon request. Such malfunctions shall be tabulated under the following headings with a full explanation of all the contributory circumstances:

8.1.1 operating errors;

8.1.2 mechanical failures (including design, installation or maintenance);
8.1.3 environmental factors (e.g. flood);
8.1.4 loss of supply services (e.g. power failure); and
8.1.5 other causes.

8.2 The Licensee must, within 24 hours, notify the Provincial Head of the occurrence or potential occurrence of any incident which has the potential to cause, or has caused water pollution, pollution of the environment, health risks or which is a contravention of the licence conditions.

8.3 The Licensee must, within 14 days, or a shorter period of time, as specified by the Provincial Head, from the occurrence or detection of any incident referred above, submit an action plan, which must include a detailed time schedule, to the satisfaction of the Provincial Head of measures taken to:-

8.3.1 correct the impacts resulting from the incident;
8.3.2 prevent the incident from causing any further impacts; and
8.3.3 prevent a recurrence of a similar incident.

9. REPORTING

9.1 The Licensee shall update the water balance annually and calculate the loads of waste emanating from the activities. The Licensee shall determine the contribution of their activities to the mass balance for the water resource and must furthermore co-operate with other water users in the catchment to determine the mass balance for the water resource reserve compliance point.

9.2 The Licensee shall submit the results of analysis for the monitoring requirements to the Provincial Head on a quarterly basis under Reference number 16/2/7/B100/C27.

9.3 The Licensee shall submit the nature and the quality of the waste disposed into the following dam.

i. Pollution control dam
ii. Dirty Water Dam for Stock Yard
iii. Stormwater Dam
iv. Pit OL

10. AUDITING

10.1 The Licensee shall conduct an annual internal audit on compliance with the conditions of this licence. A report on the audit shall be submitted to the Provincial Head within one month of finalisation of the report, and shall be made available to an external auditor should the need arise.

10.2 The Licensee shall appoint an independent external auditor to conduct an annual audit on compliance with the conditions of this licence. The first audit must be conducted within 3 (three) months of the date this license was issued and a report on the audit shall be submitted to the Provincial Head within one month of finalisation of the report.

11. INTEGRATED WATER AND WASTE MANAGEMENT

11.1 The Licensee must prepare an *Integrated Water and Waste Management Plan (IWWMP),* which must together with the *Rehabilitation Strategy* and *Implementation Programme (RSIP),* be submitted to the Provincial Head for approval within one (1) year from the date of issuance of this licence.

11.2 The IWWMP shall thereafter be updated and submitted to the Provincial Head for approval, annually.

11.3 The Licensee must, at least 180 days prior to the intended closure of any facility, or any portion thereof, notify the Provincial Head of such intention and submit any final amendments to the IWWMP and RSIP as well as a final *Closure Plan,* for approval.

11.4 The Licensee shall make full financial provision for all investigations, designs, construction, operation and maintenance for a water treatment plant should it become a requirement as a long-term water management strategy.

APPENDIX V

Section 21 (j) of the Act: Removing, discharging or disposing of water found underground if it is necessary for the effective continuation of an activity or for the safety of people

1. The licensee is authorised to remove water found underground as stipulated in table 7.

Table 7:

Water use(s)	Purpose	Capacity/ Volume (m3, tonnes and/or m3/annum)	Property Description
Pit OI Dewatering	Abstraction of water from the proposed new Block OI to the Raw Water Dam	72 000 m^3 month total for OI	Moabsvelden 248IR Portion 2 and 16

2. The Licensee is authorised to dispose the groundwater into a pollution control dam on farm Moabsvelden 248IR Portion 2 and 16
3. The licensee shall provide any water user whose water supply is impacted by the water use with potable water.
4. The quantity of water removed from underground must be metered and recorded on a daily basis.
5. The groundwater levels shall be monitored every six months (once in the beginning of the dry season and once in the beginning of the wet season).
6. Self registering flow meters must be installed in the delivery lines at easily accessible positions near the dewatering points.
7. The flow metering devices shall be maintained in a sound state of repair and calibrated by a competent person at intervals of not more than once in two years. Calibration certificates shall be available for inspection by the Provincial Head or his/her representative upon request.
8. Calibration certificates in respect of the pumps must be submitted to the

Provincial Head after installation thereof and thereafter at intervals of two years.

9. The date and time of monitoring in respect of each sample taken shall be recorded together with the results of the analysis.

10. Analysis shall be carried out in accordance with methods prescribed by and obtainable from the South African Bureau of Standards, in terms of the Standards Act, 1982 (Act 30 of 1982).

11. The methods of analysis shall not be changed without prior notification to the licensee and written approval by the Minister or his/her delegated nominee.

12. The Regional must be informed of any incident that may lead to under-groundwater being disposed of contrary to the provisions of this license, by submitting a report containing the following information:

12.1 nature of the incident (e.g. operating malfunctions, mechanical failures, environmental factors, loss of supply services, etc);

12.2 actions taken to rectify the situation and to prevent pollution or any other damage to the environment; and

12.3 measures to be taken to prevent re-occurrence of any similar incident.

13. The licensee shall follow acceptable construction, maintenance and operational practices to ensure the consistent, effective and safe performance of the underground water removal system.

14. Reasonable measures must be taken to provide for mechanical, electrical or operational failures and malfunctions of the underground water removal system.

END OF LICENCE

water & sanitation

Department
Water and Sanitation
REPUBLIC OF SOUTH AFRICA

Private Bag X313, Pretoria, 0001, Sedibeng Building, 185 Francis Baard Street, Pretoria,
Tel: (012) 336 7500 Fax (012) 323-4472 / (012) 326 - 2715

LICENCE IN TERMS OF CHAPTER 4 OF THE NATIONAL WATER ACT, 1998 (ACT NO. 36 OF 1998) (THE ACT)

I, ***Mbulelo Tshangana***, in my capacity as Acting Director-General in the Department of Water and Sanitation and acting under authority of the powers delegated to me by the Minister of Water and Sanitation, hereby authorise the following water uses in respect of this consolidated licence.

SIGNED: .....

DATE: 04/03/2020

LICENCE NO: 06/B20A/CI/9521

File No: 27/2/2/B120/36/3

1. **Licensee:** **Exxaro Coal (Pty) Ltd : Exxaro Leeupan Coal Mine Block OI West**

   Postal Address: PO Box X10580
   Bronkhorstspruit
   1020

2. **Water Uses**

2.1 Section 21(c) of the Act: Impeding or diverting the flow of water in a watercourse, Subject to the conditions as set out in Appendices I and II.

2.2 Section 21(i) of the Act: Altering the bed, banks course or characteristics of watercourse, subject to the conditions as set out in Appendices I and II

B09468

3. Properties in respect of which this license is issued

Water Uses	Property Name	Registered Property Owner	Title deeds number
Section 21 (c) & (i)	Kenbar 257 IR	Exxaro Pty (Ltd)	T9659/2002

Table 1: Properties where water uses occurs

4. Licence and Review Period

4.1 This licence is valid for a period of fifteen (15) years from the date of issuance and as provided for under Section 49 of the Act, it may be reviewed on intervals of not more than five (5) years.

5. Definitions

"Any terms, words and expressions as defined in the National Water Act, 1998 (Act 36 of 1998) shall bear the same meaning when used in this licence."

"The Provincial Head" means the Provincial Head: Mpumalanga, Department of Water and Sanitation, Private Bag X11259, Nelspruit, 1200.

"Report" refers to all documentations submitted in support of the application as well as related specialist investigations, all other related documents/submissions and communication (email, letters, etc.) related thereto.

6. Description of the activity

This licence authorises Exxaro Coal (Pty) Ltd: Leeuwpan Coal Mine for the mining of pan and hillslope seep wetland areas at Exxaro Leeuwpan Coal Mine Block OI West. The proposed activity will be undertaken at the Leeuwpan Coal Mine Block OI West located along the R50, approximately 7km from Delmas Town within the jurisdiction of Victor Khanye Local Municipality within Quaternary Catchment B20A Olifants Water Management Area in the Mpumalanga Province.

APPENDIX I

General conditions for the licence

1. This licence is subject to all applicable provisions of the National Water Act, 1998 (Act 36 of 1998).

2. The responsibility for complying with the provisions of the licence is vested in the Licensee and not any other person or body.

3. The Licensee must immediately inform the Provincial Head of any change of name, address, premises and/or legal status.

4. If the properties in respect of which this licence is issued is subdivided or consolidated, the Licensee must provide full details of all changes in respect of the properties to the Provincial Head of the Department within 60 days of the said change taking place.

5. If a water user association is established in the area to manage the resource, membership of the Licensee to this association is compulsory.

6. The Licensee will be responsible for any water use charges or levies imposed by a responsible authority.

7. The licence must not be construed as exempting the Licensee from compliance with the provisions of any other applicable Act, Ordinance, Regulation or By-law.

8. The licence and amendment of this licence are also subject to all the applicable procedural requirements and other applicable provisions of the Act, as amended from time to time.

9. The Licensee must conduct an annual internal audit on compliance with the conditions of licence. A report on the audit shall be submitted to the Provincial Head within one month of the finalisation of the audit.

10. The Licensee must appoint an independent external auditor to conduct an annual audit on compliance with the conditions of this licence. The first audit must be conducted within 3 (three) months of the date this license and a report on the audit must be submitted to the Provincial Head within one month of finalisation of the report.

11. Flow metering, recording and integrating devices shall be maintained in a sound state of repair and calibrated by a competent person at intervals of not more than two years. Calibration certificates must be available for inspection by the Provincial Head or his representative upon request.

12. Any incident that causes or may cause water pollution shall be reported to the Provincial Head or his/her designated representative within 24 hours

Appendix II

Section 21(c) of the Act: Impeding or diverting the flow of water in a watercourse; and
Section 21(i) of the Act: Altering the bed, banks, course or characteristic of a watercourse

1. General

1.1 This licence authorises the Licensee to exercise Section 21 (c) and (i) water use activities as indicated in Table 3 and in the water use licence application Reports submitted to the Department:

2 Table 3: Water Use Activities

Water Use	Purpose/Description	Properties	Volume of water (m3/a or tons/a)	Capacity (m^3)/Area(m^2 or ha)/Dimensions(m)	Coordinates
Section 21 (c) & (i)	Mining of pan/s and hillslope seep wetland areas at Exxaro Leeuwpan Coal Mine Block OI West	Kenbar 257 IR	N/A	604 m	Start: S:26.18734368736461 E:28.742857084655768 End: S:26.187083743109977 E:28.742934532992592

1.2 The Licensee must carry out and complete all the activities listed under condition 1.1 according to the following:

1.2.1 Reports submitted to the Department, specifically:

i. Wetland/Riparian Delineation and Functional Assessment Confirmation conducted by Limosella Consulting Pty Ltd, dated February 2019.
ii. Hydropedological assessment conducted by Scientific Aquatic Services, dated March 2019.
iii. Leeuwpan Coal Mine Wetland Offset Strategy Update conducted by Digby Wells and Associates (South Africa) (Pty) Ltd, dated January 2019.
iv. External Integrated Water Use Licence (IWUL) Audit (Block OI & OL)- Leeuwpan Coal Mine, conducted by GSC water and environment, dated May 2019.
v. Leeuwpan Coal Mine 2019 Integrated Water and Waste Management Plan Update conducted by GSC water and environment, dated June 2019.
vi. Stormwater Management Plan for Block OI (West) at the Leeuwpan Coal Mine conducted by GSC water and environment, dated June 2019.

vii. Exxaro Leeuwpan Coal Mine Hydrogeological Investigation Update conducted by GSC water and environment, dated June 2019.

1.2.2 Conditions of this licence, Environmental Authorisation and any other written direction issued by the Provincial Head in relation to this licence.

1.3 No activity must take place within the 1:100 year flood line or the delineated riparian habitat, whichever is the greatest, or within 500 m radius from the boundary of any wetland unless authorised by this licence.

1.4 The conditions of the authorisation must be brought to the attention of all persons (employees, sub-consultants, contractors etc.) associated with the undertaking of these activities and the Licensee must take such measures that are necessary to bind such persons to the conditions of this licence.

1.5 A suitably qualified person(s), appointed by the Licensee, and approved in writing by the Provincial Head must be responsible for ensuring that the activities are undertaken in compliance with the specifications as set out in Reports submitted to the Department and the conditions of this licence.

2. FURTHER STUDIES AND INFORMATION REQUIREMENTS

2.1. For water use activities in Table 1 & 2:

2.1.1 Updated Offset strategy must be submitted within three (3) months from the date of issuance of this licence.

3. PROTECTIVE MEASURES

3.1 Stormwater Management

3.1.1. Stormwater management practices must be constructed, operated and maintained in a sustainable manner throughout the project and for the water use activities set out in condition 1.1 and must include but are not limited to the following:

3.1.1.1. Increased runoff due to vegetation clearance and/or soil compaction must be managed, and steps must be taken to ensure that stormwater does not lead to bank instability and excessive levels of silt entering the watercourse(s);

3.1.1.2. Where the stormwater enters the river systems, sediment and debris trapping, as well as energy dissipation control structures must be put in place.

3.1.1.3. Stormwater must be diverted from activities such as construction works and roads must be managed in such a manner as to disperse runoff and to prevent the concentration of stormwater flow;

3.1.1.4. The velocity of stormwater discharges must be attenuated and the banks of the watercourses protected;

3.1.1.5. Infiltration down the verges of the roads rather than surface runoff must be encouraged.

3.2 Structures, Construction Plant and Materials

3.2.1. Necessary erosion prevention measures must be employed to ensure the sustainability of all structures

3.2.2. The height, width and length of structures must be limited to the minimum dimension necessary to accomplish the intended function.

3.2.3. Structures must not be damaged by floods exceeding the magnitude of floods occurring on average once in every 100 years.

3.2.4. Structures must be non-erosive, structurally stable and must not induce any flooding or safety hazard.

3.2.5. Structures must be inspected regularly for accumulation of debris, blockage, erosion of abutments and overflow areas - debris must be removed and damages must be repaired and reinforced immediately.

3.2.6. All areas affected by construction must be rehabilitated upon completion of the construction phase of the development. Area must be reseeded with indigenous vegetation species as required, and the use of seed nets is recommended to prevent erosion.

3.2.7. During construction phase no vehicles must be allowed to indiscriminately drive through any wetland areas.

3.3. Water Quality

3.3.1 The in-stream water quality must be analysed on a monthly basis at the monitoring points for both upstream and downstream of the river diversion for the following variables: pH, Electrical Conductivity (mS/m), Suspended Solids (mg/l), and Total Dissolved Solids (mg/l).

3.3.2 Activities (such as maintenance) that lead to elevated levels of turbidity of any watercourse must be minimised.

3.3.3 The Licensee must ensure that the quantity of the water to downstream water users does not decrease because of the existence of the infrastructure.

3.3.4 The ecological state of the water resource must not be lowered by the pro development.

3.4 Flow

3.4.1 Activities must be conducted in a manner that does not negatively affect catchment yield, hydrology and hydraulics. The Licensee must ensure that the overall magnitude and frequency of flow in the watercourse(s) does not decrease, other than for natural evaporative losses and authorised attenuation volumes.

3.4.2 Appropriate design and mitigation measures must be developed to minimise impacts on the natural flow regime of the watercourse i.e. through placement of structures/supports and to minimise turbulent flow in the watercourse.

3.4.3 Structures must be designed in a way to prevent the damming of stream/river water and not impact on the flow of the water, during the construction and operational phases of all developments.

3.4.4 Bank filling must restore the channel shape and bed level to pre-construction condition.

3.4.5 Where flow in watercourse is permanent, the trench must be staged across part of the channel to maintain flows. Flows must not be stopped.

3.5 Riparian and In-stream Habitat (Vegetation and Morphology)

3.5.1 Activities (including spill clean-up) must start up-stream and proceed into a down-stream direction, so that the recovery processes can start immediately, without further disturbance from upstream works.

3.5.2 Operation and storage of equipment must not take place within the 1:100 year flood line or delineated riparian habitat, whichever is the greatest unless authorised in this licence.

3.5.3 Activities must not occur in sensitive riffle habitats.

3.5.4 Indigenous riparian vegetation, including dead trees, outside the limits of disturbance indicated in the site plans must not be removed from the area.

3.5.5 Alien and invader vegetation must not be allowed to further colonise the area, and all new alien vegetation recruitment must be sustainably eradicated or controlled.

3.5.6 Existing vegetation composition must be maintained or improved by maintaining the natural variability in flow fluctuations. Rehabilitated areas shall have vegetation basal cover of at least 15% at all times.

3.5.7 Recruitment and maintaining of a range of size classes of dominant riparian species in perennial channels must be stimulated.

3.5.8 Encroachment of additional exotic species and terrestrial species in riparian zones must be discouraged.

3.5.9 Accumulation of woody debris on terraces by periodic flooding must be discouraged.

3.5.10 Existing flood terraces and deposition of sediments on these terraces to ensure optimum growth, spread and recruitment of these species must be maintained.

3.5.11 All reasonable steps must be taken to minimise noise and mechanical vibrations in the vicinity of the watercourses.

3.5.12 Soils that have become compacted through the water use activities must be loosened to an appropriate depth to allow seed germination.

3.5.13 Slope/bank stabilisation measures must be implemented with a 1:3 ratio or flatter and vegetated with indigenous vegetation immediately after the shaping.

3.5.15 Stockpiling of removed soil and sand must be stored outside of the 1:100 flood line or delineated riparian habitat, whichever is greater, to prevent being washed into the river and must be covered to prevent wind and rain erosion.

3.5.16 The indiscriminate use of machinery within the in-stream and riparian habitat will lead to compaction of soils and vegetation and must therefore be strictly controlled.

3.5.17 The overall macro-channel structures and mosaic of cobbles and gravels must be maintained by ensuring a balance (equilibrium) between sediment deposition and sediment conveyance maintained. A natural flooding and sedimentation regime must thus be ensured as far as reasonably possible.

3.5.18 As much indigenous vegetation growth as possible must be promoted within the proposed development area in order to protect soil and to reduce the percentage of the surface area which is paved.

3.5.19 Run-off from paved surfaces must be slowed down by the strategic placement of berms.

3.5.20 Unless authorised by this licence, access roads must not encroach into the extent of the watercourse(s).

3.6 Biota

3.6.1 The Licensee must take all reasonable steps to allow movement of aquatic species, including migratory species.

3.6.2 All reasonable steps must be taken not to disturb the breeding, nesting and/or feeding habitats and natural movement patterns of aquatic biota.

3.6.3 The current level of diversity of biotopes and communities of animals, plants and micro-organisms must be maintained.

4 REHABILITATION AND MANAGEMENT

4.1 The Licensee must embark on a systematic long-term rehabilitation programme to restore the watercourse(s) to environmentally acceptable and sustainable conditions after completion of the activities, which must include, but not be limited to the rehabilitation of disturbed and degraded riparian areas to restore and upgrade the riparian habitat integrity to sustain a bio-diverse riparian ecosystem.

4.2 All disturbed areas must be re-vegetated with an indigenous seed mix in consultation with an indigenous plant expert, ensuring that during rehabilitation only indigenous shrubs, trees and grasses are used in restoring the biodiversity.

4.3 An active campaign for controlling invasive species must be implemented within disturbed zones to ensure that it does not become a conduit for the propagation and spread of invasive exotic plants...

4.4 Compacted and disturbed areas must be shaped to natural forms and to follow the original contour. In general cut and fill slopes and other disturbed areas must not exceed 1:3 (v:h) ratio, it must be protected, vegetated, ripped and scarified parallel with the contour.

4.5 The Provincial Head must sign a release form indicating that rehabilitation was done satisfactory according to specifications as per this licence.

4.6 A photographic record must be kept as follows and submitted to the Provincial Head with reports as set out in Section 5:

4.6.1 Dated photographs of all the sites to be impacted before construction commences;

4.6.2 Dated photographs of all the sites during construction on a monthly basis; and

4.6.3 Dated photographs of all the sites after completion of construction, seasonally.

4.7 Rehabilitation structures must be inspected regularly for the accumulation of debris, blockages instabilities and erosion with concomitant remedial and maintenance actions.

4.8 A comprehensive and appropriate rehabilitation and management programme to restore the watercourse(s) to environmentally acceptable and sustainable conditions after construction must be developed and submitted to the Provincial Head for a written approval within one (1) month from the date of issuance of this licence.

4.9 A Wetland Management and Rehabilitation Plan must be compiled by a wetland specialist where wetlands are affected and submitted to the Provincial Head for a written approval.

4.10 Wetland crossing(s) must be visited by a wetland specialist prior to construction to determine baseline conditions. This must be repeated during and after rehabilitation measures have been implemented to assess the success of rehabilitation and erosion control measures.

5. MONITORING AND REPORTING

5.1. The Provincial Head must be notified in writing one week prior to commencement of the licensed activities and again upon completion of the activities.

5.2 A comprehensive and appropriate environmental assessment and monitoring programme (including bio-monitoring) to determine the impact, change, deterioration and improvement of the aquatic system associated with the activities listed under condition 1.1 (Appendix II) as well as compliance to these water use licence conditions must be developed and submitted to the Provincial Head for a written approval before commencement and must subsequently be implemented as directed.

5.3 Six (6) monthly monitoring reports must be submitted to the Provincial Head until otherwise agreed in writing with the Provincial Head.

5.4 A qualified and responsible scientist must be retained by the Licensee who must give effect to various licence conditions and to ensure compliance thereof pertaining to all activities of impeding and/or diverting flow of watercourses as well as alterations to watercourses on the properties as set out in condition 1.1.

5.5 The Licensee must conduct annual internal audit on compliance with the conditions of this licence. A report on the audit must be submitted to the Provincial Head within one month of the finalisation of the audit. A qualified independent auditor must undertake this audit.

5.6 The audit reports must include but are not limited to:

5.6.1 Reporting in respect of the monitoring programme referred to in condition 5.2;
5.6.2 A record of implementation of all mitigation measures including a record of corrective actions; and
5.6.3 Compensation measures for damage where mitigation measures have failed to adequately protect the in-stream and riparian habitat or any other characteristic of the watercourses.

5.7 The Licensee must apply in writing to the Provincial Head for alternative reporting arrangements for which written approval must be provided.

5.8 An Environmental Management/Monitoring Committee (EMC) must be established consisting of, but not limited to, representatives of the Licensee, the Responsible Person(s) for ensuring compliance with this licence, the Department of Water and Sanitation, the relevant Department of Environmental Affairs, the Department of Minerals and Resources, and other stakeholders.

5.9 The CME must in addition to monitoring compliance with the conditions of the Environmental Management Programme Report, monitor for the duration of its establishment compliance with the conditions of this water use licence.

6. OTHER WATER USERS

6.1 The Licensee must attempt to prevent adverse effect on other water users. All complaints must be investigated by a suitable qualified person and if investigations prove that the Licensee has impaired the rights of other water users, the Licensee must initiate suitable compensative measures.

7. POLLUTION PREVENTION, INCIDENTS AND MALFUNCTIONS

7.1 Pollution incidents must be dealt with in accordance with the Act.

7.2 If surface and/or groundwater pollution has occurred or may possibly occur, the Licensee must conduct, and/or appoint specialists to conduct the necessary investigations and implement additional monitoring, pollution prevention and remediation measures to the satisfaction of the Provincial Head.

7.3 The Licensee must keep all records relating to the compliance or non-compliance with the conditions of this licence in good order. Such records shall be made available to the

Provincial Head within fourteen (14) days of receipt of a written request by the Department for such records.

7.4 The Licensee must keep an incident report and complaints register, which must be made available to any external auditors and the Department.

8. BUDGETARY PROVISIONS

8.1 The Licensee must ensure that there is a budget sufficient to complete and maintain the water use and for successful implementation of the rehabilitation programme as set out in this licence.

8.2 The Provincial Head may at any stage of the process request proof of budgetary provisions for rehabilitation and closure of project.

9. SITE SPECIFIC CONDITIONS

9.1 The proposed wetland offset strategy must be refined, submitted for approval within three (3) months from the date of issuance of this licence.

9.2 The AMD treatment strategy must be refined, submitted for approval within three (3) months from the date of issuance of this licence.

9.3 AN active treatment plant and passive treatment plant must be implemented.

9.4 Success of offset rehabilitation must be reported upon yearly.

9.5 A thorough investigation must be conducted to establish the hydraulic connectivity between the two aquifers (the Karoo Supergroup aquifer and the Malmani dolomite aquifers) as the impact on one might affect the other.

9.6 The depth of boreholes RIE4, RIE10 and RIE10B must be investigated to check if these were drilled within the Malmani dolomitic aquifer, if not then new boreholes must be drilled to monitor the aquifer as it is vital in sustaining the large scale irrigation in the area.

9.7 There is evidence of groundwater pollution in the vicinity of mining activities as determined by water quality results. These impacts must be kept as local as possible and ponding must be avoided by implementation of proper storm water drainage system in these areas so that horizontal and vertical movement of pollution plume towards the underlying aquifers could be minimised.

9.8 groundwater monitoring network must be dynamic and be expanded as mining progresses, in terms of background, source, pathways and receptor principles. However, the applicant must inform the department before such changes could be made.

9.9 Mined out monitoring boreholes must be replaced by equal-depth boreholes at appropriate locations.

9.10 Monitoring of groundwater levels and quality must be conducted as proposed, meaning quarterly on all monitoring boreholes, including some privately-owned hydro-censes boreholes that showed evidence of pollution, e.g., RIE1 and RIE2. Owners of the affected boreholes must be compensated sufficiently.

9.11 Dewatered volumes must be recorded and excessive dewatering must be avoided by e.g., sealing of high-yielding fractures encountered during opencast mining, as these might reduce the yield of privately-owned hydro-census production boreholes in the area. This will also create a safe working environment in the pit.

9.12 Decant locations must be identified and management measures must be devised beforehand to ensure the protection of water resource in the area.

9.13 Treatment of future decant to dischargeable or reuse standards must be investigated to ensure the protection of water resources and their users in the area.

9.14 The drilling of monitoring boreholes into backfilled mining area is recommended so that recovery of water and water quality in such areas can be monitored to calibrate, refine and validate the models and ultimately device appropriate groundwater management measure post-mining.

9.15 Since rehabilitation or backfilling of opencast pits occurs concurrently or immediately after mining, it is recommended, as proposed also in the report that backfilled areas must be free-draining, compacted to discourage infiltration into the mined out areas, and also minimise formation of AMD by flooding and baring of oxygen from reacting with remaining pyrite.

9.16 It is highly recommended that groundwater monitoring continue to take place even after mining has ceased for a period of 4 to 10 years, in the backfilled area and existing monitoring boreholes, the results of which will be presented annually to the Government for closure objectives negotiations.

9.17 Groundwater management report must be submitted to this office every year.

9.18 It is recommended that the reasons for the decline of the water quality downstream of the proposed activity along the bronkhorstspriut river be investigated;

9.19 It is recommended that surface water monitoring should be conducted on a monthly basis and groundwater should be conducted on a quarterly basis to be submitted to the regional office;

9.20 It is recommended that the Leeuwpan mine test all surface and groundwater monitoring points for a full spectrum of heavy metals twice a year.

9.21 Dewatering at Leeuwpan Coal Mine Block OI and Block OI West must not exceed the dewatering volume of 72 000 m^3/a as authorised under the existing licence (licence No. 04/B20A/CIJ/4032) for Leeuwpan Coal Block OI.

[END OF LICENCE]

Annexure G
Wetland Delineation Assessment



Wetland Delineation and Assessment for the Exxaro Leeuwpan Coal Mine near Delmas, Mpumalanga



For:

Riana Panaino
P.O. Box 2597
Rivonia
2128
Tel: (011) 803 5726
riana@gcs-sa.biz

By:

Wetland Consulting Services (Pty) Ltd

Wetland Consulting Services (Pty.) Ltd.
PO Box 72295
Lynnwood Ridge
Pretoria
0040

Tel: 012 349 2699
Fax: 012 349 2993
Email: info@wetcs.co.za

Reference: 842/2012

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PROJECT:	**Wetland Delineation and Assessment for the Exxaro Leeuwpan Coal Mine near Delmas, Mpumalanga**
CLIENT:	**GCS (Pty.) Ltd.**
CONTACT DETAILS:	**GCS (Pty.) Ltd.** **Jaco Viviers** **P.O. Box 2597** **Rivonia** **2128** **Tel: (011) 803 5726** **Email:** jaco@gcs-sa.biz
CONSULTANT:	**Wetland Consulting Services, (Pty) Ltd.**
CONTACT DETAILS:	**PO Box 72295** **Lynnwood Ridge** **0040** **Telephone number: (012) 349 2699** **Fax number: (012) 349 2993** **E-mail:** info@wetcs.co.za

TABLE OF CONTENTS

1. BACKGROUND INFORMATION 6

2. SCOPE OF WORK 6

3. LIMITATIONS & ASSUMPTIONS 7

4. STUDY AREA 7

4.1 Catchments 8
4.2 Geology and Soils 9
4.3 Vegetation 10
4.4 National Freshwater Ecosystem Priority Areas 13

5. APPROACH 14

5.1 Wetland Delineation and Classification 14
5.2 Brief history of wetland delineation in South Africa 15
5.3 Water Quality and Diatoms 16
5.4 Functional Assessment 16
5.5 Present Ecological State and Ecological Importance & Sensitivity 17

6. FINDINGS 17

6.1 Wetland Delineation and Classification 17
6.2 Water Quality and Diatoms 20
6.2.1 Water Quality 20
6.2.2 Diatoms 22
6.3 Wetland Assessment 24
6.3.1 Functional Assessment 25
6.3.2 Hillslope seepage wetlands 25
6.3.3 Valley bottom wetlands 27
6.3.4 Pans/Depressions 28
6.4 Present Ecological Status (PES) Assessment 28
6.5 Ecological Importance and Sensitivity (EIS) 32

7. IMPACT ASSESSMENT 36

7.1 Project Description 36
7.2 Impact Assessment Methodology 37
7.3 Opencast Coal Mining 38
7.3.1 Loss and disturbance of wetland habitat 40
7.3.2 Increased surface runoff from bare soil areas 41
7.3.3 Increased sediment transport into wetlands 42
7.3.4 Decreased water make to downslope wetlands 42
7.3.5 Loss and disturbance of wetland habitat 43
7.3.6 Increased surface runoff from bare soil areas 43
7.3.7 Increased sediment transport into wetlands 44
7.3.8 Water quality deterioration 44
7.3.9 Altered hydrology 45

7.3.10 Deteriorating water quality 45
7.3.11 Increased sediment transport into wetlands 46
7.3.12 Increase in alien vegetation 46
7.4 Conveyors and roads 47
7.4.1 Loss and disturbance of wetland habitat 48
7.4.2 Increased erosion and sedimentation 48
7.4.3 Deteriorating Water Quality due to Coal Spillages 49
7.4.4 Stormwater discharge into the wetlands 49
7.4.5 Altered flows in the wetland 50
7.4.6 Mobilisation of pollutants 50
7.4.7 Disturbance of wetland habitat and fauna 51
7.4.8 Increased sediment movement into wetlands 51
7.5 Other linear infrastructure 52
7.5.1 Loss and disturbance of wetland habitat 52
7.5.2 Increased erosion and sedimentation 53
7.5.3 Piping and preferential flow paths 53
7.5.4 Altered water movement through the landscape 53
7.5.5 Water quality deterioration 54
7.5.6 Water quality deterioration due to leaks or pipe failure 54
7.5.7 Disturbance to wetland habitat due to maintenance activities 54
7.5.8 Mobilisation of pollutants 55
7.5.9 Disturbance of wetland habitat and fauna 55
7.5.10 Increased sediment movement into wetlands 55
7.6 Surface infrastructure 56
7.6.1 Loss of wetland habitat 56
7.6.2 Increased sediment movement into wetlands 58
7.6.3 Increase in alien and pioneer vegetation 58
7.6.4 Water quality deterioration 59
7.6.5 Increased surface runoff and erosion 59
7.6.6 Deterioration in water quality 60
7.6.7 Mobilisation of pollutants 60
7.6.8 Disturbance of wetland habitat and fauna 61
7.6.9 Increased sediment movement into wetlands 61
7.7 Water management infrastructure 62
7.7.1 Loss of wetland habitat 62
7.7.2 Increased sediment movement into wetlands 64
7.7.3 Increase in alien and pioneer vegetation 64
7.7.4 Water quality deterioration 65
7.7.5 Water quality deterioration - Seepage out of the dams 65
7.7.6 Water quality deterioration – Overflow of dams 66
7.7.7 Erosion due to overflow of dams 66
7.7.8 Disturbance to wetland habitat and biota 67
7.7.9 Increased occurrence of alien and weedy species 67
7.7.10 Water quality deterioration 68
7.7.11 Increased sediment movement into wetlands 68

8. REHABILITATION 69

8.1 Fencing or demarcation of affected area 69
8.2 Re-vegetation/ rehabilitation 69
8.3 The eradication of invasive plant species 70
8.4 Guide to installing erosion and siltation preventing devices: 71

9. MONITORING & EVALUATION 73

9.1 Vegetation re-establishment 73

9.2 Erosion 73
9.3 Surface water quality monitoring program 73

10. CONCLUSION 75

11. REFERENCES 78

APPENDIX 1: 81

APPENDIX 2: 84

APPENDIX 3: 87

TABLE OF FIGURES

Figure 1: Map showing the location of the study area within the mining right area of Leeuwpan Coal Mine 8

Figure 2: Map showing the Leeuwpan Coal Mine study area in relation to the quaternary catchment 9

Figure 3: Geology map of the Leeuwpan Coal Mine mining right area derived from the 1:250 000 geological map of the area, 2628 East Rand 10

Figure 4: Map showing the vegetation mapping units of the area according to Mucina and Rutherford (2006) 11

Figure 5: Extract of the Atlas of Freshwater Ecosystem Priority Ares in South Africa (Nel *et al*., 2011) 14

Figure 6: Diagram illustrating the position of the various wetland types within the landscape 15

Figure 7: Map of the delineated wetlands on within the Leeuwpan Coal Mine mining right areas and adjacent areas 19

Figure 8: Map showing the location of water quality and diatom sampling sites 20

Figure 9: Map of the wetland units within the Leuwpan Coal Mine mining right area showing the numbering system 24

Figure 10: Radial plots showing the results of the WET-EcoServices assessment 26

Figure 11: Radial plots showing the results of the WET-EcoServices assessment 28

Figure 12: Radial plots showing the results of the WET-EcoServices assessment 28

Figure 13: Results of the PES assessments for wetlands on site 30

Figure 14: Map showing the numbering system used for the pans 31

Figure 15: Map showing the results of the EIS assessment 35

Figure 16: Delineated wetlands within the proposed opencast pits. Wetlands to be mined through have been highlighted in orange 39

Figure 17. Map showing the proposed surface infrastructure and mining areas. 47

Figure 18: Proposed new surface infrastructure in relation to delineated wetlands 57

Figure 19: Proposed new water management infrastructure in relation to delineated wetlands 63

Figure 20: A siltation screen below a construction site to prevent the movement of sediment downstream (image from www.wikipedia.com)....71

Figure 21: Photograph of fibre rolls from EPA erosion control website....72

Figure 22: Additional points (shown as yellow circles) to include within the surface water quality monitoring programme for the mine....74

Figure 23: Map showing the delineated wetlands on site with a 500m buffer. Any activity proposed within the buffer area will require authorisation under a Water Use License.....77

TABLE OF TABLES

Table 1: Table showing the mean annual precipitation, run-off and potential evaporation per quaternary catchment (Middleton, B.J., Midgley, D.C and Pitman, W.V., 1990)....8

Table 2: Table showing the extent of the various geological formations on site....10

Table 3: Summarised findings of the wetland ecosystem threat status assessment as undertaken by the National Biodiversity Assessment 2011: Freshwater Component (Nel *et al*., 2011b) for wetland ecosystems recorded on site....12

Table 4: Extent of the various wetland types recorded on site....17

Table 5: Results of the water quality analyses undertaken....21

Table 6: Results of the ICP-OES scan for metals undertaken for the water samples....22

Table 7. Results of the PES assessment. 29

Table 8: Results of the Level 1 WET-Health assessment....31

Table 9: Results of the PES assessment for the pans on site....32

Table 10: Table showing the rating scale used for the PES assessment....32

Table 11: Results of the EIS assessment....34

Table 12: Scoring system used for the EIS assessment....35

INDEMNITY AND CONDITIONS RELATING TO THIS REPORT

The findings, results, observations, conclusions and recommendations given in this report are based on the author's best scientific and professional knowledge as well as available information. The report is based on survey and assessment techniques which are limited by time and budgetary constraints relevant to the type and level of investigation undertaken and Wetland Consulting Services (Pty.) Ltd. and its staff reserve the right to modify aspects of the report including the recommendations if and when new information may become available from ongoing research or further work in this field, or pertaining to this investigation.

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1. BACKGROUND INFORMATION

Wetland Consulting Services (Pty.) Ltd. was appointed by GCS (Pty.) Ltd. to undertake the wetland delineation and impact assessment for the proposed EIA/EMP consolidation for the Exxaro Leeuwpan Coal Mine near Delmas in the Mpumalanga Province.

The requirement to establish the existence and/or extent of wetlands on the property is based on the legal requirements contained in the National Environmental Management Act (NEMA) (Act No 107 of 1998) and the National Water Act (Act No 36 of 1998), as well as the Mineral and Petroleum Resources Development Act (MPRDA) (Act No 28 of 2002). Given the stringent legislation regarding developments within or near wetland areas, it is important that these areas are identified and developments planned sensitively around them to minimize any potential impacts.

The purpose of this document is to describe the wetlands within the study area, to identify existing impacts of current mining activities on wetlands, to identify and assess expected impacts on the wetlands due to the proposed developments and to provide recommendations regarding appropriate mitigation and/or management measures to be implemented should the proposed activities be authorised.

2. SCOPE OF WORK

The following task formed part of the agreed upon scope of work.

Baseline Assessment:

- Review of existing available data;
- Delineation and classification of all the wetlands within the study area;
- Determination of the Present Ecological State and Ecological Importance and Sensitivity of all the wetlands identified within the study area;
- Functional Assessment of all the wetlands identified;
- Collection and analysis of water and diatom samples;
- Present Ecological State (PES) and Ecological Importance and Sensitivity (EIS) of aquatic ecosystems on site using the DWAF scoring system (DWAF, 1999);
- Identify and map sensitive areas; and
- Compilation of all the findings in a specialist report.

Impact Assessment:

- Identify all the impacts on aquatic ecosystems resulting from the proposed developments;
- Evaluate all identified impacts based on a significance rating scale embracing notions such as extent, magnitude, duration and significance of impacts;
- Recommend suitable mitigation and management measures, where applicable, to minimise any potential impacts; and
- Provide a comprehensive impact assessment report detailing all the information.

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3. LIMITATIONS & ASSUMPTIONS

Due to the scale of the remote imagery used (1:10 000 orthophotos and Google Earth Imagery), as well as the accuracy of the handheld GPS unit used to delineate wetlands in the field, the delineated wetland boundaries cannot be guaranteed beyond an accuracy of about 20m on the ground. Should greater mapping accuracy be required, the wetlands would need to be pegged in the field and surveyed using conventional survey techniques.

The temporary edges of especially hillslope seepage wetlands are extensively cultivated and transformed on site, precluding the use of vegetation indicators in determining wetland boundaries in these areas and thus reducing the confidence of the delineation accuracy in those areas where cultivation extends into the wetlands.

The impact assessment was based on the mine plan as provided by GCS (Pty.) Ltd. Activities not indicated on the provided mine plan were not assessed.

4. STUDY AREA

The Leeuwpan Coal Mine Mining Rights Area (MRA), which forms the study boundaries for the current study, is located to the south east of the town of Delmas in the Mpumalanga Province. The R50 road from Delmas to Leandra traverses the western and southern reaches of the site.

The study area, which covers 4 260 hectares, includes portions of the following Farms:

- Witklip 232-IR;
- Witklip 229-IR;
- Wolvenfontein 244-IR;
- Goedgedacht 228-IR;
- Leeuwpan 246-IR;
- De Denne 256-IR;
- Rietkuil 249-IR;
- Moabsvelden 248-IR; and
- Weltevreden 227-IR.

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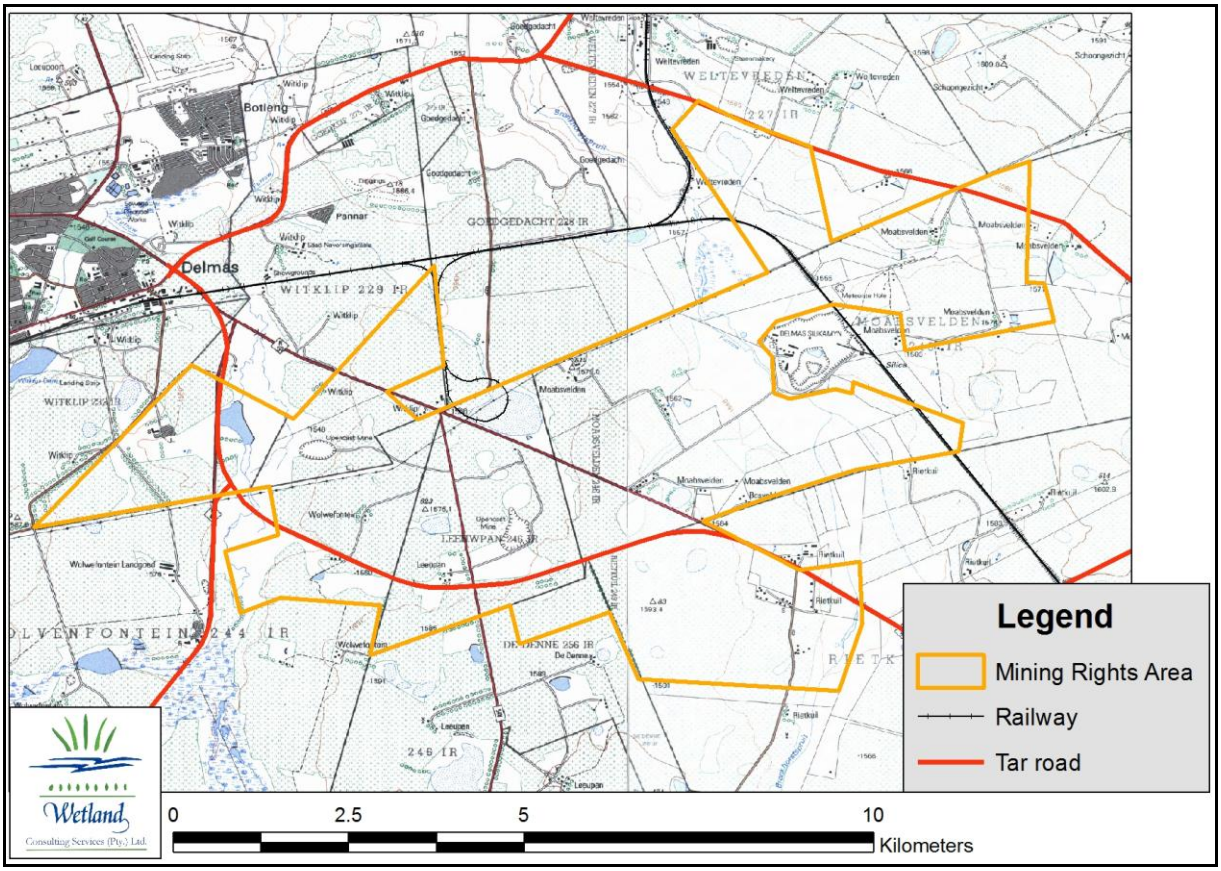


Figure 1: Map showing the location of the study area within the mining right area of Leeuwpan Coal Mine

4.1 Catchments

The study area is located within the Olifants River Catchment (Primary Catchment B); more specifically within the Bronkhorstspruit sub-catchment of the Upper Olifants Catchment. The affected quarternary catchment, which is drained by the Bronkhorstspruit and its tributaries, is catchment B 20 A.

Information regarding catchment size, mean annual rainfall and runoff for the quaternary catchment is provided in the table below (Middleton, B.J., Midgley, D.C and Pitman, W.V., 1990).

Table 1: Table showing the mean annual precipitation, run-off and potential evaporation per quaternary catchment (Middleton, B.J., Midgley, D.C and Pitman, W.V., 1990)

Quaternary Catchment	Catchment Surface Area (ha)	Mean Annual Rainfall (MAP) in mm	Mean Annual Run-off (MAR) in mm	MAR as a % of MAP	Study area as a % of the catchment
B 20 A	51 852	661.16	37.9	5.73 %	8.21 %

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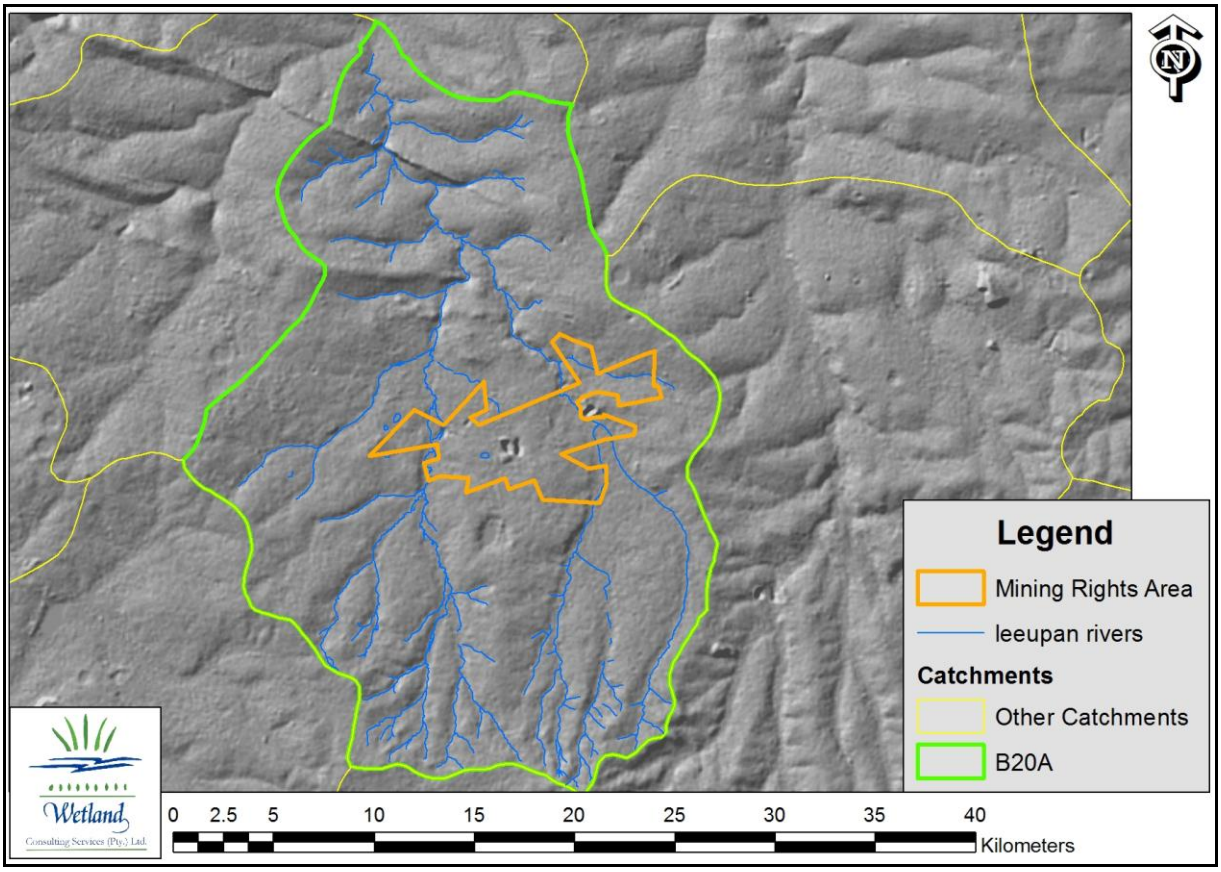


Figure 2: Map showing the Leeuwpan Coal Mine study area in relation to the quaternary catchment

4.2 Geology and Soils

According to the 1:250 000 Geological Map Series map (2628 East Rand), the geology of the study area is dominated by sandstones of the Vryheid Formation, Ecca Group, Karoo Sequence, which cover more than two thirds of the site. Significant alluvial deposits occur along the larger drainage lines that traverse the study site, while roughly 11 % of the study area is underlain by Malmani dolomites of the Chuniespoort Formation.

Sandstones weather to form sandy soils that allow easy infiltration of rainwater into the soil and thus result in minimal runoff (less than 6 % of the rainfall within the catchment ends up as surface runoff). Typically these soils however have an aquitard within the soil profile that prevents the deeper infiltration of rainwater into groundwater, resulting in shallow perched water tables across large portions of the landscape. Where this perched water table approaches the surface and results in the seasonal or permanent saturation of the top 50 cm of the soil profile, wetland conditions develop, typically in the form of large hillslope seepage wetlands that drain into valley bottom or pan wetlands.

Soils derived from dolomite are also typically sandy and well-drained, but do not support perched water tables as readily, as water tends to infiltrate deeper into groundwater. This result in decreased wetland extent in these areas compared to sandstone areas, but also results in higher

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groundwater yields, as witnessed by the centre pivot irrigation of the Delmas area that is supported by the dolomitic aquifers of the area.

Table 2: Table showing the extent of the various geological formations on site

Geology	Formation	Area (ha)	% of study area
Sandstone	Vryheid	2 902.4	68 %
Alluvium	n/a	635.5	15 %
Dolomite	Chuniespoort	483.0	11 %
Dolerite	n/a	127.2	3 %
Diamictite	Dwyka	95.4	2 %
Shale	West Rand	12.7	< 1 %
Ferruginous shale	Pretoria	10.7	< 1 %

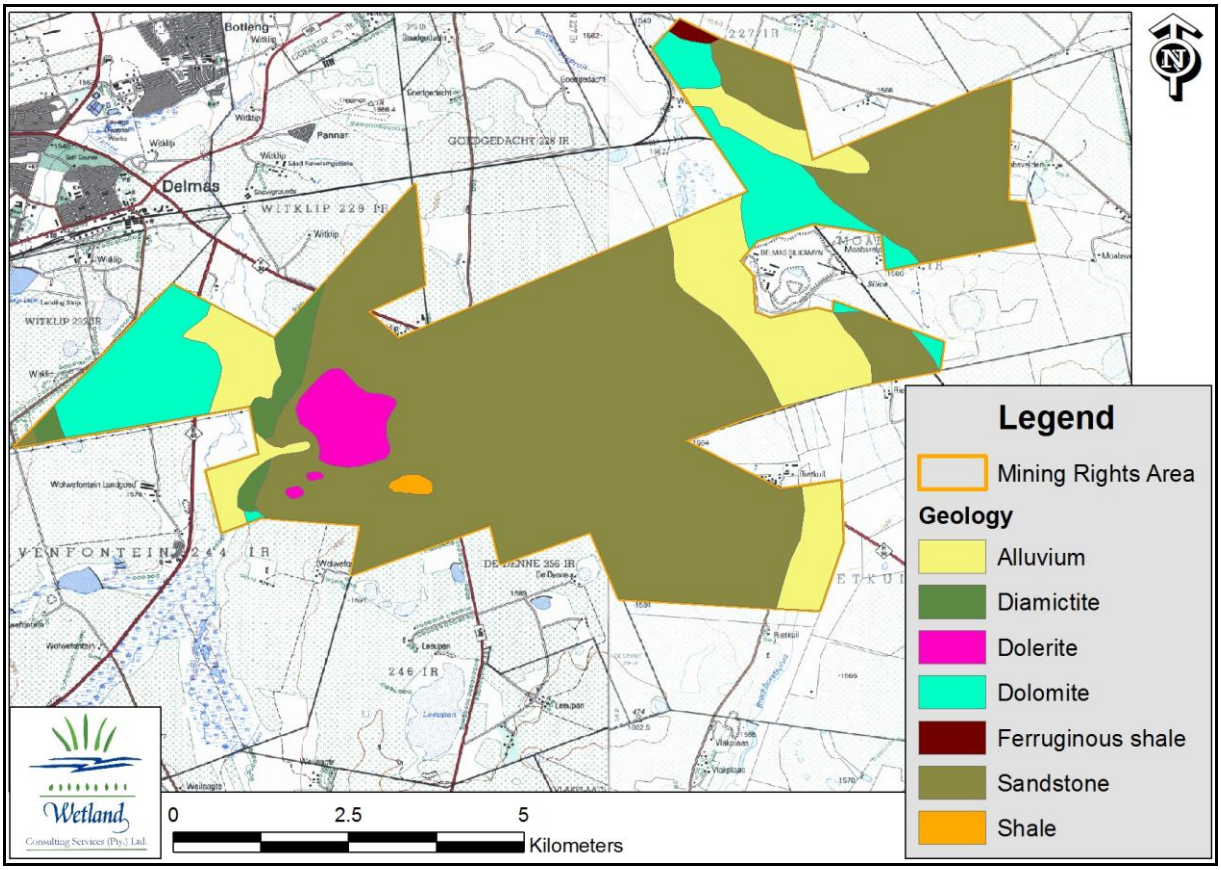


Figure 3: Geology map of the Leeuwpan Coal Mine mining right area derived from the 1:250 000 geological map of the area, 2628 East Rand

4.3 Vegetation

A number of vegetation classification systems have been compiled for South Africa. Initially Acocks (1953) classified the vegetation as being of the Bankenveld (Veld Type 61) (eastern half of the site) and *Themeda* Veld (Turf Highveld) (Veld Type 52) vegetation types. Low and Rebelo (1996) classified the vegetation of the area as Moist Cool Highveld Grassland (Vegetation Type 39) and Moist Sandy Highveld Grassland (Vegetation Type 38). According to the most recent vegetation

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classification of the country however, "*The Vegetation of South Africa, Lesotho and Swaziland*" (Mucina and Rutherford, 2006), the study area falls within the Grassland Biome, Mesic Highveld Grassland Bioregion. At a finer level, the study area is classed predominantly as Eastern Highveld Grassland (Mapping Unit Gm 12), though a narrow band of Soweto Highveld Grassland (Mapping Unit Gm 8 occurs along the large eastern drainage line. Eastern Temperate Freshwater Wetlands (Mapping Unit AZf 3)vegetation is indicated as occurring within one of the larger pans on site, though it is pointed out that most of this pan has been destroyed by mining activities and an associated rail loop.

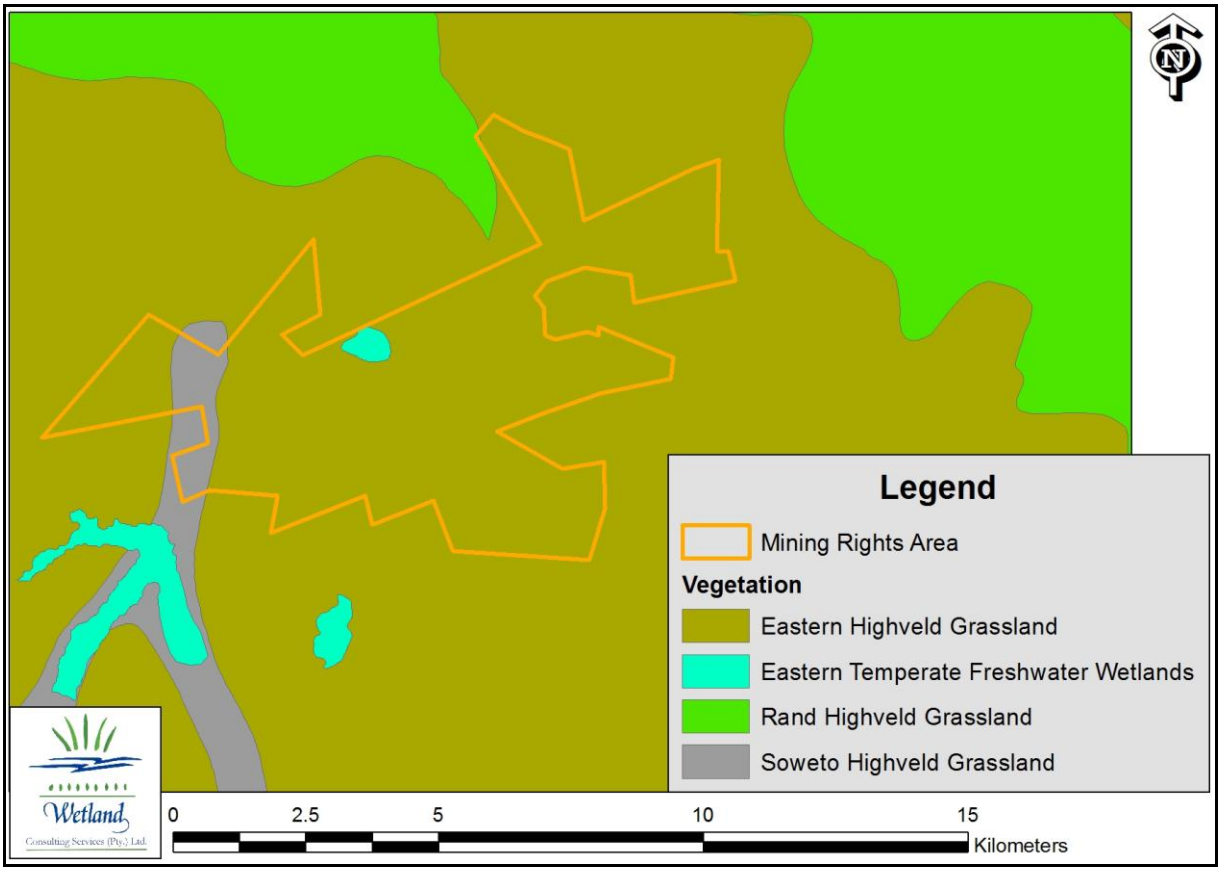


Figure 4: Map showing the vegetation mapping units of the area according to Mucina and Rutherford (2006)

<u>*Eastern Highveld Grassland*</u> (Mapping Unit Gm 12) is mostly confined to Mpumalanga and western Swaziland, occurring marginally as well into Gauteng. The conservation status of this vegetation type is Endangered (Mucina & Rutherford, 2006), and whilst the conservation target is 24%, only a small fraction (<1%) is currently protected and 44% is considered to be transformed, mostly by cultivation, forestry, mines, dams and urbanisation. Typical species composition, according to Mucina & Rutherford (2006), is as follows:

Graminoids: *Andropogon appendiculatus* (d), *Brachiaria serrata* (d), *Digitaria monodactyla* (d), *D. tricholaenoides* (d), *Elionurus muticus* (d), *Eragrostis capensis* (d), *E. chloromelas* (d), *E. plana* (d), *E. racemosa* (d), *Harpochloa falx* (d), *Heteropogon contortus* (d), *Microchloa caffra* (d), *Panicum natalense* (d), *Setaria nigrirostris* (d), *S. sphacelata* (d), *Themeda triandra* (d), *Trichoneura grandiglumis* (d), *Tristachya leucothrix* (d),

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Abilgaardia ovata, *Andropogon schirensis*, *Aristida bipartita*, *A. congesta*, *A. junciformis* subsp. *galpinii*, *A. stipittata* subsp. *graciliflora*, *Bulbostylis contexta*, *Chloris virgate, Cymbopogon caesius, C. pospischilii, Cynodon dactylon, Digitaria diagonalis, D. ternate, Diheteropogon amplectens, Eragrostis curvula, Koeleria capensis, Panicum coloratum*, and *Setaria incrassata*.

Herbs: *Berkheya setifera* (d), *Vernonia natalensis*, *V. oligocephala* (d), *Acalypha peduncularis, A. wilmsii, Berkheya insignis, B. pinnatifida, Crabbea acaulis, Cynoglossum hispidum, Dicoma anomala, Haplocarpha scaposa, Helichrysum caespititium, H. rugulosum, Hermannia coccocarpa, H. depressa, H. transvaalensis, Ipomoea crassipes, I. oblongata, Jamesbrittenia silenoides, Pelargonium luridum, Pentanisia prunelloides* subsp. *latifolia, Peucedanum magalismontanum, Pseudognaphalium luteo-album, Rhynchosia effusa, Salvia repens, Schistostephium crataegifolium, Sonchus nanus*, and *Wahlenbergia undulata*.

Geophytic herbs: *Gladiolus crassifolius, Haemanthus humilis* subsp. *hirsutus, Hypoxis rigidula* var. *pilosisima* and *Ledebouria ovatifolia*.

The recently published Atlas of Freshwater Ecosystem Priority Areas in South Africa (Nel *et al*, 2011a) (The Atlas) identified 791 wetland ecosystem types in South Africa based on classification of surrounding vegetation (taken from Mucina and Rutherford, 2006) and hydro-geomorphic (HGM) wetland type; seven HGM wetland types are recognised and 133 wetland vegetation groups. Based on this classification, the following wetland vegetation types are indicated as occurring on site:

- Mesic Highveld Grassland Group 3_Channelled valley bottom
- Mesic Highveld Grassland Group 4_Seep
- Mesic Highveld Grassland Group 4_Flat
- Mesic Highveld Grassland Group 4_Depression
- Mesic Highveld Grassland Group 4_Channelled valley bottom
- Mesic Highveld Grassland Group 4_Unchannelled valley bottom

The National Biodiversity Assessment 2011: Freshwater Component (Nel *et al*., 2011b) undertook an ecosystem threat status assessment for each of the 791 wetland ecosystem types where each wetland ecosystem type was assigned a threat status based on wetland type as well as on wetland vegetation group. A summary of the findings for the 7 wetland ecosystem types expected to occur on site is provided in Table 2 below.

Table 3: Summarised findings of the wetland ecosystem threat status assessment as undertaken by the National Biodiversity Assessment 2011: Freshwater Component (Nel *et al*., 2011b) for wetland ecosystems recorded on site

Wetland Ecosystem Type	Wetland HGM Type (WT)	Threat Status of WT	Protection level of WT	Wetland Vegetation Group (WVG)	Threat Status of WVG
Mesic Highveld Grassland Group 3_Channelled valley bottom	Channelled valley bottom	CR	Zero protection	Mesic Highveld Grassland	CR

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Wetland Ecosystem Type	Wetland HGM Type (WT)	Threat Status of WT	Protection level of WT	Wetland Vegetation Group (WVG)	Threat Status of WVG
Mesic Highveld Grassland Group 4_Seep	Seep	EN	Zero protection	Mesic Highveld Grassland	CR
Mesic Highveld Grassland Group 4_Flat	Flat	CR	Zero protection	Mesic Highveld Grassland	CR
Mesic Highveld Grassland Group 4_Depression	Depression	CR	Hardly protected	Mesic Highveld Grassland	CR
Mesic Highveld Grassland Group 4_Channelled valley bottom	Channelled valley bottom	CR	Hardly protected	Mesic Highveld Grassland	CR
Mesic Highveld Grassland Group 4_Unchannelled valley bottom	Unchannelled valley bottom	CR	Zero protection	Mesic Highveld Grassland	CR

CR = Critically Endangered, implying area of wetland ecosystem type in good (A or B) condition ≤ 20% of its original area
EN = indicates Endangered, area of wetland ecosystem type in good condition ≤ 35% of its original area

From the above table it is clear that the wetland ecosystem types represented within the Leeuwpan Coal Mine MRA are all considered Critically Endangered in terms of both the wetland vegetation group they fall into, and the wetland types (except for seeps, which are considered Endangered) that they represent.

4.4 National Freshwater Ecosystem Priority Areas

The Atlas of Freshwater Ecosystem Priority Areas in South Africa (Nel *et al*, 2011) (the Atlas) which represents the culmination of the National Freshwater Ecosystem Priority Areas project (NFEPA), a partnership between SANBI, CSIR, WRC, DEA, DWA, WWF, SAIAB and SANParks, provides a series of maps detailing strategic spatial priorities for conserving South Africa's freshwater ecosystems and supporting sustainable use of water resources. Freshwater Ecosystem Priority Areas (FEPA's) were identified through a systematic biodiversity planning approach that incorporated a range of biodiversity aspects such as ecoregion, current condition of habitat, presence of threatened vegetation, fish, frogs and birds, and importance in terms of maintaining downstream habitat. The Atlas incorporates the National Wetland Inventory (SANBI, 2011) to provide information on the distribution and extent of wetland areas. An extract of the NFEPA database is illustrated in Figure 5 below.

In the case of the Leeuwpan Colliery study area, the Atlas indicates numerous wetlands falling within the study area, but no wetland or river FEPA's occur within or within the direct vicinity of the site. ***The fact that no wetland FEPA's are indicated as occurring on site does however not imply that the wetlands on site are of lesser importance, though the PES assessment detailed further below in this report highlights that the wetlands on site have been extensively impacted and degraded by both agricultural activities and mining activities***.

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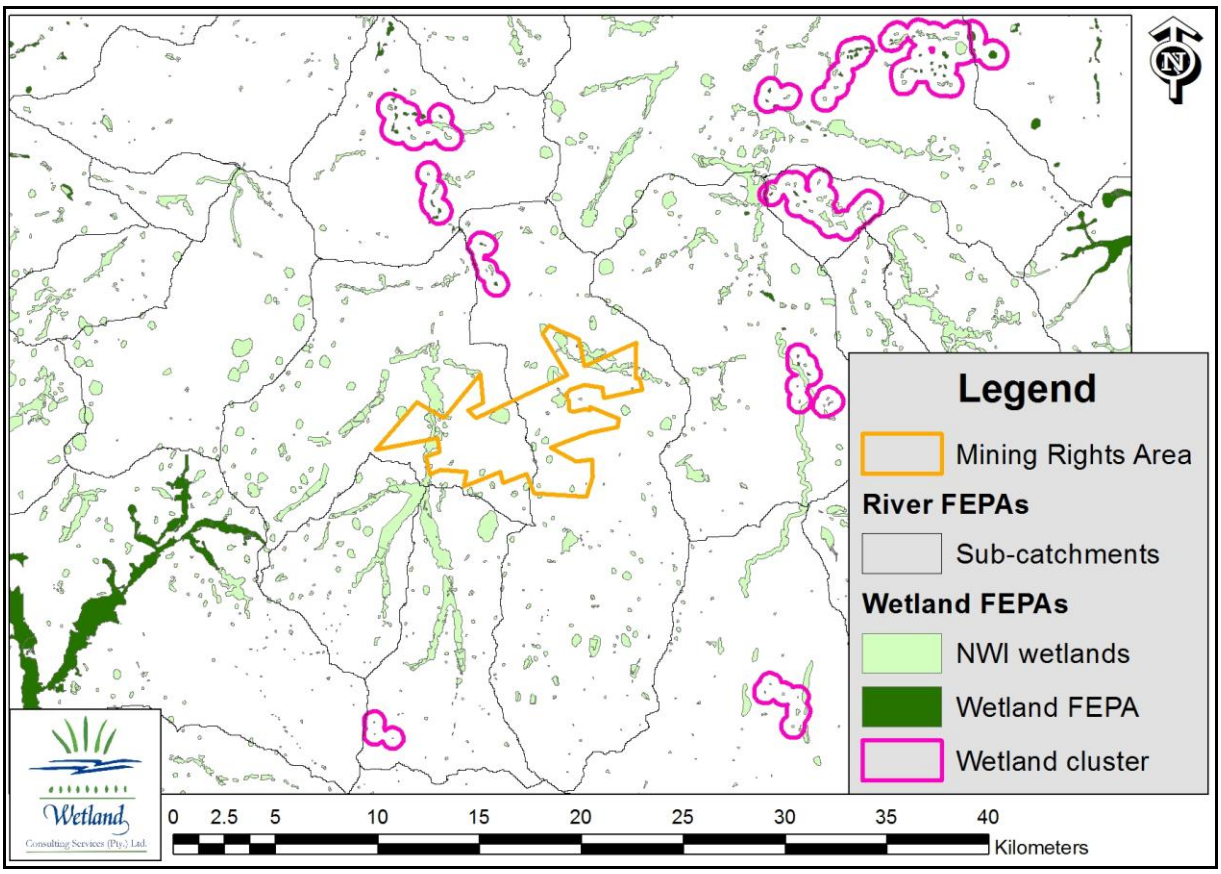


Figure 5: Extract of the Atlas of Freshwater Ecosystem Priority Ares in South Africa (Nel *et al*., 2011)

5. APPROACH

5.1 Wetland Delineation and Classification

The National Water Act, Act 36 of 1998, defines wetlands as follows:

> *"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."*

The presence of wetlands in the landscape can be linked to the presence of both surface water and perched groundwater. Wetland types are differentiated based on their hydro-geomorphic (HGM) characteristics; i.e. on the position of the wetland in the landscape, as well as the way in which water moves into, through and out of the wetland systems. A schematic diagram of how these wetland systems are positioned in the landscape is given in the figure below.

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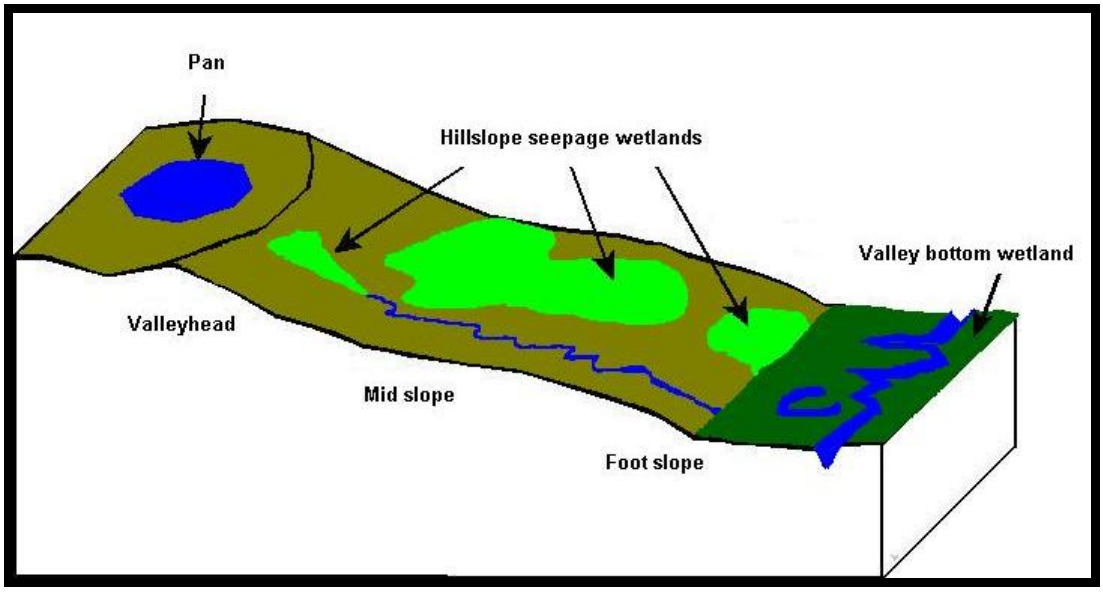


Figure 6: Diagram illustrating the position of the various wetland types within the landscape

Use was made of 1:50 000 topographical maps, 1:10 000 orthophotos and Google Earth Imagery to create digital base maps of the study area onto which the wetland boundaries could be delineated using ArcMap 9.0. A desktop delineation of suspected wetland areas was undertaken by identifying rivers and wetness signatures on the digital base maps. All identified areas suspected to be wetlands were then further investigated in the field.

Wetlands were identified and delineated according to the delineation procedure as set out by the "*A Practical Field Procedure for the Identification and Delineation of Wetlands and Riparian Areas*" document, as described by DWAF (2005) and Kotze and Marneweck (1999). Using this procedure, wetlands were identified and delineated using the Terrain Unit Indicator, the Soil Form Indicator, the Soil Wetness Indicator and the Vegetation Indicator.

For the purposes of delineating the actual wetland boundaries use is made of indirect indicators of prolonged saturation, namely wetland plants (hydrophytes) and wetland soils (hydromorphic soils), with particular emphasis on hydromorphic soils. It is important to note that under normal conditions hydromorphic soils must display signs of wetness (mottling and gleying) within 50cm of the soil surface for an area to be classified as a wetland (*A practical field procedure for identification and delineation of wetlands and riparian areas*, DWAF).

The delineated wetlands were then classified using a hydro-geomorphic classification system based on the system proposed by Brinson (1993), and modified for use in South African conditions by Marneweck and Batchelor (2002).

5.2 Brief history of wetland delineation in South Africa

The current wetland delineation guidelines were published by the DWAF in 2005, which details a wetland delineation methodology based on the methodology initially developed by Kotze and Marneweck in 1999 as part of the Resource Directed Measures for Protection of Water Resources: Wetland Ecosystems (DWAF 1999). This delineation methodology drew extensively from wetland

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delineation procedures utilised in the United States of America (e.g. U.S. Fish and Wildlife Service et al., 1989) and was designed for the needs of the reserve process.

Prior to the wetland delineation methodology developed by Kotze and Marneweck (1999), no national wetland delineation methodology existed in South Africa. A number of initiatives were however undertaken in the late 90's to inform wetland identification, delineation and management. Published literature produced as part of these various initiatives include '*Improved criteria for classifying hydric soils in South Africa*' by Kotze et al. (1996) and the Wetland-use Booklet Series produced as part of the Rennie's Wetland Project, '*What is a Wetland?*' and '*How wet is a wetland?*' (Kotze, 1997). At the time, the Forest Owners Association Environmental Committee also compiled '*A practical procedure for the delineation of riparian/wetland habitats for land use practices in South Africa*' (1999).

Wetland delineation as currently practiced in South Africa thus roughly dates back to 1999, with very limited prior work having been undertaken and widely implemented prior to this date.

Prior to the National Water Act (Act 36 of 1998), which was only promulgated in 1998, the Conservation of Agricultural Resources Act (CARA) was the deciding statute on wetland utilisation (Phragmites. 2005). CARA limited wetlands and the utilisation thereof to the 1:10 year floodline. In effect, this thus excluded all hillslope seepage wetlands, and only valley bottom wetlands and pans were considered to fall within this definition.

5.3 Water Quality and Diatoms

Diatoms are the unicellular algal group most widely used as indicators of wetland health as they provide a rapid response to specific physico-chemical conditions in the water and are often the first indication of change. The presence or absence of indicator taxa can be used to detect specific changes in environmental conditions such as eutrophication, organic enrichment, salinisation and changes in pH. They are therefore useful for providing an overall picture of trends within an aquatic system.

Preparation of diatom slides followed methods as outlined in Taylor *et a*l. (2007). The aim of the data analysis was to identify and count diatom valves (400 counts) to produce semi-quantitative data from which ecological conclusions can be drawn (Taylor *et al.* 2007).

Grab water samples were collected from a number of wetland systems on site and submitted to the SANAS accredited Waterlab laboratory in Pretoria for analysis.

5.4 Functional Assessment

A functional assessment of the wetlands on site was undertaken using the level 2 assessment as described in "Wet-EcoServices" (Kotze *et al*., 2007). This method provides a scoring system for establishing wetland ecosystem services. It enables one to make relative comparisons of systems based on a logical framework that measures the likelihood that a wetland is able to perform certain functions.

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5.5 Present Ecological State and Ecological Importance & Sensitivity

A present ecological state (PES) and ecological importance and sensitivity (EIS) assessment was conducted for every hydro-geomorphic wetland unit identified and delineated within the study area. This was done in order to establish a baseline of the current state of the wetlands and to provide an indication of the conservation value and sensitivity of the wetlands in the study area.

For the purpose of this study, the scoring system as described in the document "*Resource Directed Measures for Protection of Water Resources. Volume 4. Wetland Ecosystems*" (DWAF, 1999) was applied for the determination of the PES.

6. FINDINGS

6.1 Wetland Delineation and Classification

In total ***the area classified as wetland covers 1 382 hectares, which makes up roughly 32.5 % of the study area***. Approximately 820 hectares of the site has however already been disturbed by surface mining activities, suggesting that the wetland extent on site was likely significantly more prior to the onset of mining activities.

Table 4: Extent of the various wetland types recorded on site

Wetland Type	Wetland Area (ha)	% of wetland area	% of study area
Channelled valley bottom	77.77	5.63%	1.83%
Hillslope seepage	906.55	65.58%	21.28%
Pan	37.02	2.68%	0.87%
Unchannelled valley bottom	321.78	23.28%	7.55%
Dam	35.98	2.60%	0.84%
River diversion	3.15	0.23%	0.07%
TOTAL	**1 382.25**	**100.00%**	**32.45%**

The wetland extent on site is dominated by extensive hillslope seepage wetlands. These wetlands make up more than 65 % of the wetland area on site and cover more than 20 % of the entire site. The majority of the seepage wetlands are considered seasonal to temporary wetlands (i.e. implying temporary to seasonal saturation of the soil profile) that are maintained by a shallow perched water table within the soil profile. The perched water table is derived and maintained from rainfall that infiltrates the soil profile and is prevented from deeper infiltration by an aquitard within the soil profile, usually a hard of soft plinthic layer. It is suspected that little interaction between

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deeper groundwater and this perched water table occurs, though no testing or modeling to support this statement was undertaken on site.

In many areas the temporary edges of the hillslope seepage wetlands have been cultivated and are either still currently under maize cultivation or have been converted to planted pastures. Especially on the Farm Rietkuil the intrusion of cultivation into the hillslope seepage wetlands has been extensive. Nonetheless, the remaining areas of hillslope seepage wetland characterised by natural vegetation represent, together with the two large valley bottom wetlands, the largest expanse of natural grassland within the study area.

Three valley bottom wetlands were delineated within the study area, consisting of the Bronkhorstspruit and two of its tributaries. Some confusion exists with regards to the naming of the Bronkhorstspruit, as the 1:50 000 topographical maps name the large valley bottom wetland in the east of the site as the Bronkhorstspruit, while road signs along the R50 tar road name the western valley bottom as the Bronkhorstspruit. For the purpose of this study, the naming as per the 1:50 000 topographical maps will be followed.

The Bronkhorstspruit valley bottom wetland consists of a broad, mostly unchannelled system characterised by vertic clay soils. The upper catchment as well as the upper reach of the wetland on site is utilised agriculturally, with livestock grazing the main activity within the wetland. On site, mining takes place on either side of the wetland and includes the Silica Mine that extends significantly into the wetland. A dam as well as several berms have been constructed within this reach of the wetland to control flows through the mining area. Downstream of the study area the character of the wetland changes significantly as flows become confined and a clearly incised channel forms where the alluvial deposits associated with the upper wetland end and the river flows over dolomite.

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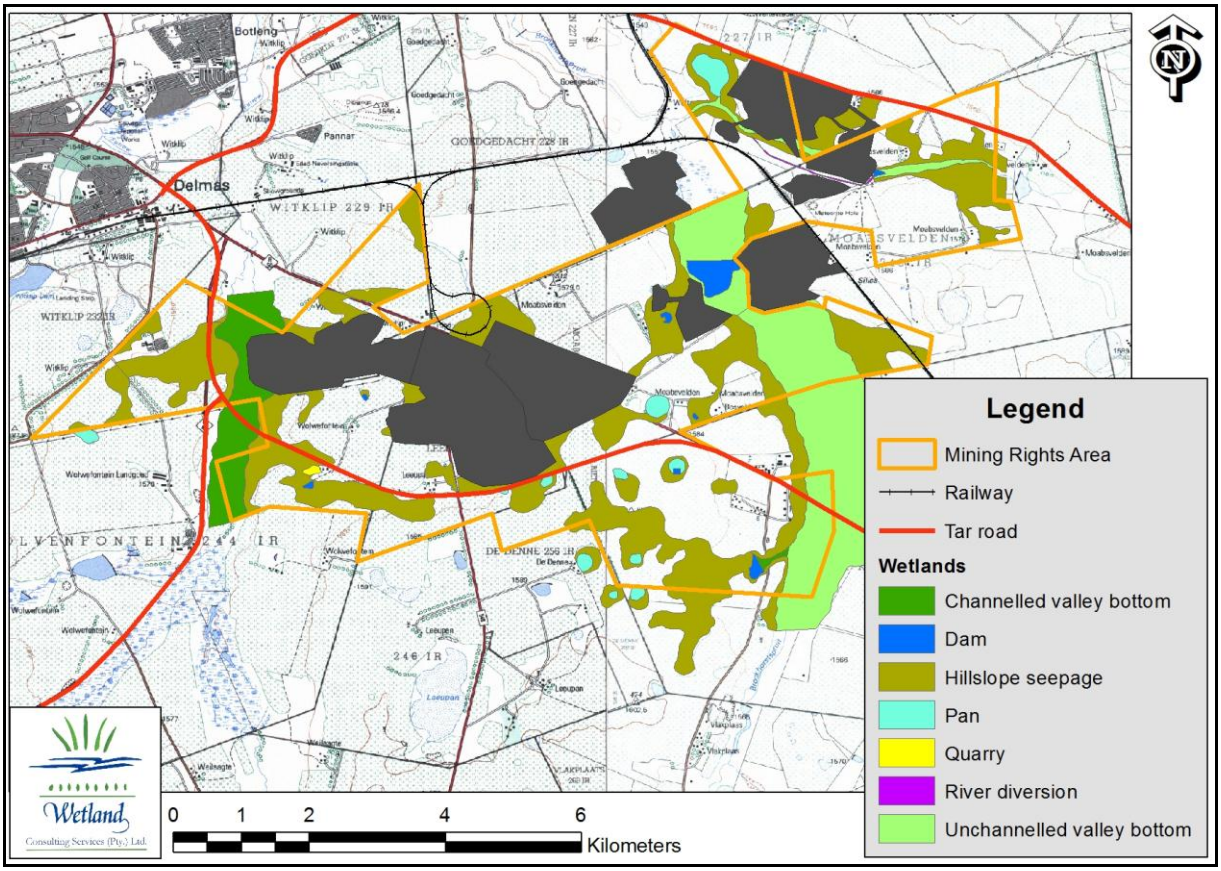


Figure 7: Map of the delineated wetlands on within the Leeuwpan Coal Mine mining right areas and adjacent areas

A small unnamed tributary enters the Bronkhorstspruit from the east. This valley bottom wetland passes between the Leeuwpan Coal Mine mining activities and the Stuart East Colliery mining area and has necessitated a river diversion. A dam has been constructed on the upstream side of the mining activities and channels flows via a narrow, approximately 3m wide trench, around the mining activities.

In the east of the study area a further unnamed tributary of the Bronkhorstspruit flows from south to north across the study area. This is again a broad valley bottom wetland characterised by mostly vertic soils, though in contrast to the Bronkhorstspruit system on site, this system is clearly incised. Existing mining activities also extend into this wetland system and have required the construction of a large berm to divert flows around the mine activities. Tthis activity has been authorized under the WULA that was submitted and approved for the mining of the OWM Reserves (Koos Smit, *pers. comm*., 2013)

Eight pans occur within the study area, ranging in size from 0.4 to over 18 hectares. Most of these pans are shallow, seasonal depressions that are characterised by *Leersia hexandra* across their full width, though the pan at sampling point LP2 (see Figure 8 below) appears to be a permanent pan as it is lined by *Phragmites australis*. This pan is thought to be used as water storage for irrigation and is thus a highly modified system. A number of further pans have been significantly impacted by the construction of roads and irrigation dams within the pan basins.

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A total of 119 plant species were identified within the wetlands of the area, a complete list of which is provided in Appendix 2. Most of the species encountered are widespread species and also include a number of weeds and exotic species. No Red Data species was encountered on site, though the habitat within the larger valley bottom wetlands characterised by vertic soils might be suitable for *Kniphofia typhoides,* which has also been recorded on adjacent sites in the area. Other species of lesser conservation concern, but of rarer occurrence in Highveld wetlands that were encountered on site include *Eucomis autumnalis*, *Gladiolus crassifolius*, *Crinum bulbispermum*, *Erythrina zeyheri* and *Hypoxis hemerocallidea*. Within the hillslope seepage wetlands especially, a large number of weedy species were encountered along the wetland edges as a result of disturbances associated with cultivation extending into the wetlands.

6.2 Water Quality and Diatoms

6.2.1 Water Quality

Five (5) water quality samples were collected from the larger wetlands within the study area as well as upstream and downstream thereof, with the location of sampling points indicated in Figure 9. At the time of sampling, April 2012, flow within the various wetlands was very low, and most samples were collected from stagnant pools within the wetlands with no discernible flow. This, together with the fact that only once-off grab samples were collected, needs to be considered when assessing the results. However, the results are expected to provide a general indication of water quality within the sampled systems.

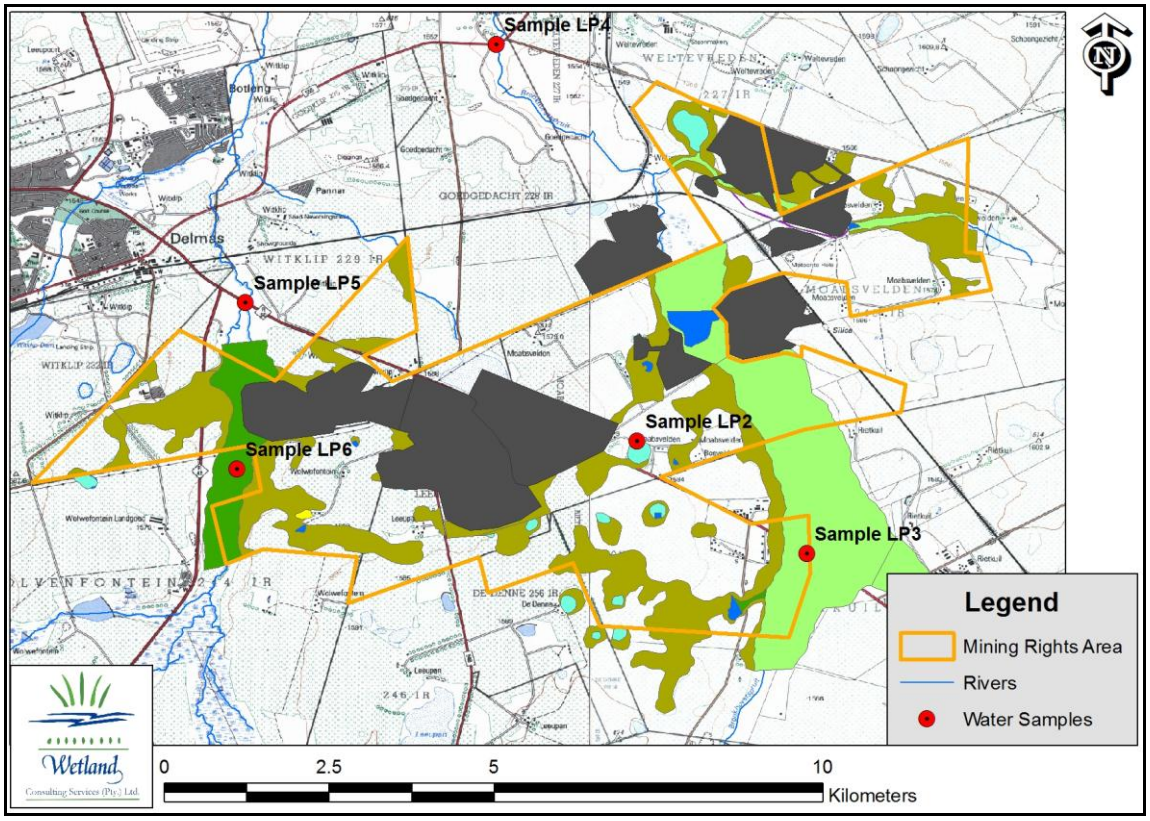


Figure 8: Map showing the location of water quality and diatom sampling sites

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Sample site LP2 is a pan that seems to be used for irrigation by farmers, and it is thought that groundwater is pumped into the pan for storage and then used for irrigation (this assumption is based on pumping infrastructure observed along the shore of the pan). The water quality within the pan is thus highly modified, though still of a generally good quality. Slightly elevated sulphate levels (46 mg/l) appear to indicate some degree of mining impact to the pan.

Sample sites LP3 and LP4 were collected from the same valley bottom system, upstream and downstream of the mining activities respectively. A small increase in sulphate levels from upstream to downstream is likely associated with the mining activities taking place either side of the valley bottom wetland. Elevated TDS levels at site LP3 are considered to be due to concentration via evaporation, as the sample was collected from a small puddle of stagnant water within the wetland.

Sample sites LP5 and LP6 show relatively good quality water that do not yet reflect any significant impact from mining with low sulphate levels recorded; 9 mg/l and <5 mg/l respectively.

Table 5: Results of the water quality analyses undertaken

Variable	LP2	LP3	LP4	LP5	LP6	Guidelines Aquatic Ecosystems	Guidelines Domestic Use
pH (@ 25ºC)	7.6	7.7	7.7	7.8	8.1	-----	6 - 9
Electrical Conductivity (mS/m)	54	73	39	49	50.2	-----	-----
Total Dissolved Solids (mg/l)	334	476	260	286	294	-----	0 - 450
Total Alkalinity as $CaCO_3$ (mg/l)	176	256	92	224	252	-----	N/A
Chloride as Cl (mg/l)	43	77	18	25	22	N/A	0 - 100
Sulphate as SO_4 (mg/l)	46	33	78	9	<5	N/A	0 - 200
Fluoride as F (mg/l)	0.4	0.7	0.3	0.4	0.3	0.75	0 - 1
Nitrate as N (mg/l)	0.4	0.3	0.3	0.3	0.3	----	0 - 6
Free & Saline Ammonia as N (mg/l)	0.5	0.4	0.2	0.2	<0.2	0.007	0 – 1.0

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Table 6: Results of the ICP-OES scan for metals undertaken for the water samples

Element	LP2	LP3	LP4	LP5	LP6	Guidelines Aquatic Ecosystems	SANS 241
Ag	<0.025	<0.025	<0.025	<0.025	<0.025	n/a	n/a
Al	<0.100	0.106	<0.100	<0.100	<0.100	0.01 mg/l	< 0.3 mg/l
As	<0.010	<0.010	0.01	<0.010	0.011	0.010 mg/l	< 0.010
B	0.088	0.027	0.028	<0.025	<0.025	n/a	n/a
Ba	0.158	0.248	0.096	0.211	0.113	n/a	n/a
Be	<0.025	<0.025	<0.025	<0.025	<0.025	n/a	n/a
Bi	<0.025	<0.025	<0.025	<0.025	<0.025	n/a	n/a
Ca	38	54	30	34	38	n/a	< 150 mg/l
Cd	<0.005	<0.005	<0.005	<0.005	<0.005	0.00025 mg/l	<0.005 mg/l
Co	<0.025	<0.025	<0.025	<0.025	<0.025	n/a	<0.5 mg/l
Cr	<0.025	<0.025	<0.025	<0.025	<0.025	0.007 mg/l	< 0.1 mg/l
Cu	<0.025	<0.025	<0.025	<0.025	<0.025	0.0008 mg/l	< 1.0 mg/l
Fe	<0.025	<0.025	<0.025	<0.025	<0.025	n/a	< 0.2 mg/l
K	5.6	18.5	13	7.8	7.1	n/a	0 - 50 mg/l
Li	<0.025	<0.025	<0.025	<0.025	<0.025	n/a	n/a
Mg	23	28	18	28	33	n/a	< 70 mg/l
Mn	0.542	0.517	0.132	0.123	0.107	0.18 mg/l	< 0.1 mg/l
Mo	<0.025	<0.025	<0.025	<0.025	<0.025	n/a	n/a
Na	35	48	16	19	14	n/a	< 200 mg/l
Ni	<0.025	0.039	<0.025	<0.025	<0.025	n/a	< 0.15 mg/l
P	0.193	0.165	0.092	0.09	0.095	n/a	n/a
Pb	<0.020	<0.020	<0.020	<0.020	<0.020	0.0005 mg/l	< 0.02 mg/l
Sb	<0.010	<0.010	<0.010	<0.010	<0.010	n/a	<0.010
Se	<0.020	<0.020	<0.020	<0.020	<0.020	0.002 mg/l	< 0.02 mg/l
Si	3.6	1.8	0.3	1.1	1.6	n/a	n/a
Sn	0.086	0.07	0.08	0.081	0.064	n/a	n/a
Sr	0.43	0.327	0.151	0.157	0.14	n/a	n/a
Ti	<0.025	<0.025	<0.025	<0.025	<0.025	n/a	n/a
Tl	<0.025	<0.025	0.027	0.025	0.031	n/a	n/a
V	<0.025	<0.025	<0.025	<0.025	0.026	n/a	< 0.2 mg/l
W	<0.025	<0.025	<0.025	<0.025	<0.025	n/a	n/a
Zn	0.069	<0.025	<0.025	<0.025	<0.025	0.002 mg/l	< 5.0 mg/l
Zr	<0.025	<0.025	<0.025	<0.025	<0.025	n/a	n/a

6.2.2 Diatoms

Pans and valley bottom wetlands may have naturally elevated salinity and nutrient levels in comparison to some freshwater systems, and any attempt to use indices of biotic integrity suitable for freshwater ecosystems in South Africa (Specific Pollution Index IPS, Coste in CEMAGREF, 1982, Biological Index for Diatoms BDI, Lenoir and Coste, 1996, Prygiel and Coste, 2000) will likely result in misleading interpretations.

Analyses of diatoms were therefore based on measures of relative abundance and species composition (i.e. assemblage patterns) to infer baseline water quality conditions at these sites. There were insufficient cell counts at site LP1 therefore any conclusions on water quality based on diatom communities could not be formulated. Appendix A displays a list of species and abundances recorded for sites LP2-6.

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To further determine water quality based on diatom composition at the Leeuwpan sites, diatoms assemblages collected from 206 sites throughout the Highveld were included in a cluster analysis to provide a more reliable inference of water quality.

Diatom assemblage patterns at the Leeuwpan sites (Appendix A) suggest the following (remembering that 'pollution indicators' used to determine anthropogenic stress in freshwater systems may be equally tolerant to the natural stressors that accompany healthy, eutrophic wetland systems):

- Site LP2 is dominated by species found in waters with moderate electrolyte content such as *Amphora pediculus* and *Cyclostephanos invisitatus*. The presence of taxa *Nitzschia fonticola*, *Gomphonema exilissimum* and *Placoneis placentula*, good indicators of clean waters and tolerant of slight to moderate levels of pollution may imply that the water quality at this site is in relatively good condition. The presence of taxa *Aulacoseira granulata* and *Nitzschia palea* points to some nutrient enrichment.
- At site LP3, prevalent taxon *Gomphonema parvulum* is usually a red flag for some type of pollution. *G. parvulum* is often linked to a source of organic and nutrient inputs. Sub-dominant taxa such as *Navicula symmetrica* and *Nitzschia palea* are found in waters with elevated nutrient and electrolyte concentrations. Dominant taxon *Fragilaria ulna* var. *acus* points to elevated levels of inorganic nutrients.
- At site LP4, to note is the high abundance of *Mayamaea atomus*, one of the most pollution resistant diatoms found in alkaline, heavily polluted waters with high electrolyte content, but also occurring in moderate quality waters often associated with organic detritus. Dominant taxon *Nitzschia palea* points to nutrient and electrolyte enrichment.
- The overall diatom assemblage for sites LP5 and LP6 indicates reasonably good water quality. The sites are comprised of species found in standing and slow flowing waters of moderate to high electrolyte content such as *Gyrosigma attenuatum, Rhopalodia gibba, Epithemia adnata* and *Epithemia sorex*. Both sites are dominated by the *Achnanthidium* genus which may occur across a gradient of nutrient and salinity impacts but never found in waters with critical levels of organic pollution. The presence of taxon *Nitzschia dissipata* var. *media* is a good indicator of hard water (calcium based salinity) and favours alkaline conditions.
- Species present at sites LP5 and LP6 such as *Navicula trivialis, Nitzschia palea, Mayamaea atomus, Eolimna minima* and *Sellaphora seminulum* indicate some level of nutrient and organic input at these sites.
- Cluster analysis of Leeuwpan sites along with 206 wetland sites across the Highveld (WCS diatom database, unpublished data) revealed the following:
  - Site LP2 was related (but not so closely) to a pan with elevated salinity as a result of high sulphate concentrations.
  - Site LP3 was closely related to a channelled system impacted by organics and nutrients from urban developments.
  - Site LP4 was grouped with a channelled valley bottom site downstream of a mine, having relatively good water quality with some nutrient and electrolytes inputs.
  - Sites LP5 and LP6 were closely grouped with channelled valley bottom sites in relatively good condition with some signs of organic and nutrient inputs.

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6.3 Wetland Assessment

All of the wetlands identified and delineated within the Leeuwpan Coal Mine MRA were assessed individually in terms of:

- Present Ecological Status (WET-Health Level 1); and
- Ecological Importance and Sensitivity.

For ease of discussion, each of the affected wetland units was numbered, with the numbering system shown in **Figure 9**.

For purposes of the Functional Importance (WET-EcoServices), similar wetland units of the same hydro-geomorphic type and characteristics were grouped and a single functional assessment was undertaken for each group:

- Hillslope seepage wetlands connected to a watercourse;
- Hillslope seepage wetlands connected to a pan;
- Isolated hillslope seepage wetlands;
- Pan wetlands;
- Channelled valley bottom wetlands; and
- Unchannelled valley bottom wetlands - Bronkhorstspruit

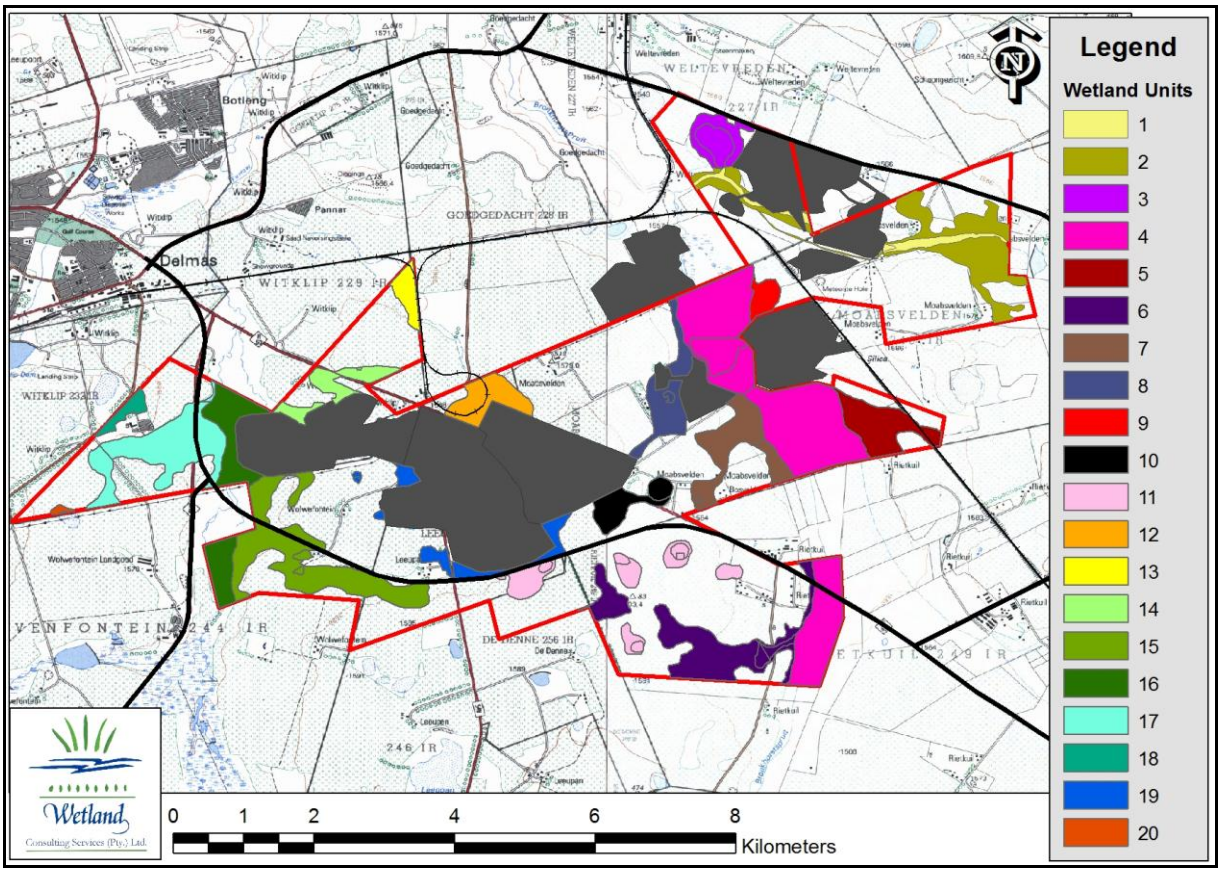


Figure 9: Map of the wetland units within the Leuwpan Coal Mine mining right area showing the numbering system

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6.3.1 Functional Assessment

Wetlands have been shown to perform a wide range of functions related to water quality improvement, flood attenuation, resource provision and erosion control, among others. However, each wetland is unique in the extent to which it is able to perform these functions, and the opportunity it is provided to perform these functions. Many of the functions and services attributed to a wetland are inferred from the HGM classification of the wetland, as well as the levels of disturbance, cultural importance, and potential for the wetland to perform various functions. The nature of the functions that the wetlands perform and the services they provide were assessed using the WET-EcoServices tool, whereby both existing information and a field assessment were required.

At a site specific scale, as well as at the local and regional scale, the wetlands (especially the large valley bottom wetlands) represent the dominant remaining extent of natural vegetation and thus play a highly significant role in biodiversity support at this level. Virtually all terrestrial habitat on site has been significantly transformed due to agricultural and mining activities and most terrestrial areas are under cultivation, forcing species that under natural conditions might not be directly dependent on wetland habitats to frequent wetland habitats on site. Loss of the wetland habitat on site would thus result not only in the loss of wetland dependent fauna, but also impact significantly on terrestrial faunal species that remain on site. At the National and International level, the importance of many of the smaller hillslope seepage wetlands and pans in biodiversity support is limited due to the disturbances that have already taken place within these systems, the generally low species richness of wetlands compared to other ecosystems (e.g. terrestrial grassland), and the limited number of Red Data species likely to occur on site.

6.3.2 Hillslope seepage wetlands

As alluded to earlier, hillslope seepage wetlands are maintained by shallow sub-surface interflow, derived from rainwater. Rainfall infiltrates the soil profile, percolates through the soil until it reaches an impermeable layer (e.g. a plinthic horizon or the underlying sandstone), and then percolates laterally through the soil profile along the aquitard (resulting in the formation of a perched water table). Such a perched water table occurs across large areas of the Mpumalanga Highveld, not only within hillslope seepage wetlands, but also within terrestrial areas, only at greater depth. The hillslope seepage wetlands are merely the surface expression of this perched water table in those areas where a shallow soil profile results in the perched water table leading to saturation of the profile within 50cm of the soil surface. The importance of individual seepage wetlands in temporarily storing and then discharging flows to downslope wetlands (flow regulation) varies and depends on a number of factors. Generally, seepage wetlands associated with springs and located adjacent to terrestrial areas characterised by deep, well-drained soils are more likely to play an important role in flow regulation than seepage wetlands where the wetland and catchment are characterised by shallower soils. Such seepage wetlands are likely often maintained mostly by direct rainfall and lose most of their water to evapotranspiration, and surface run-off during large storm events.

Hillslope seeps can support conditions that facilitate both sulphate and nitrate reduction as interflow emerges through the organically rich wetland soil profile, and are thus thought to

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contribute to water quality improvement and/or the provision of high quality water. The greatest importance of the hillslope seepage wetlands on site is thus taken to be the movement of clean water through the hillslope seepage wetlands and into the adjacent valley bottom wetlands, though the flow contribution from hillslope seepage wetlands to downslope wetlands was not quantified.

As hillslope seepage wetlands, for the most part, are dependent on the presence of an aquiclude, either a hard or soft plinthic horizon, they are not generally regarded as significant sites for groundwater recharge (Parsons, 2004). However, by retaining water in the landscape and then slowly releasing this water into adjacent valley bottom or floodplain wetlands, some hillslope seepage wetlands can contribute to stream flow augmentation, especially during the rainy season and early dry season. From an overall water yield perspective there is evidence that seepage wetlands contribute to water loss. The longer the water is retained on or near the surface the more likely it is to be lost through evapo-transpiration (McCartney, 2000). Hillslope seepage wetlands are not generally considered to play an important role in flood attenuation, though early in the season, when still dry, the seeps have some capacity to retain water and thus reduce surface run-off. Later in the rainy season when the wetland soils are typically saturated, infiltration will decrease and surface run-off increase. Further flood attenuation can be provided by the surface roughness of the wetland vegetation; the greater the surface roughness of a wetland, the greater is the frictional resistance offered to the flow of water and the more effective the wetland will be in attenuating floods (Reppert et al., 1979). In terms of the hillslope seepage wetlands on site, the surface roughness is taken to be moderately low, given that most of the seepage wetlands are either cultivated of characterised by typical grassland vegetation, thus offering only slight resistance to flow.

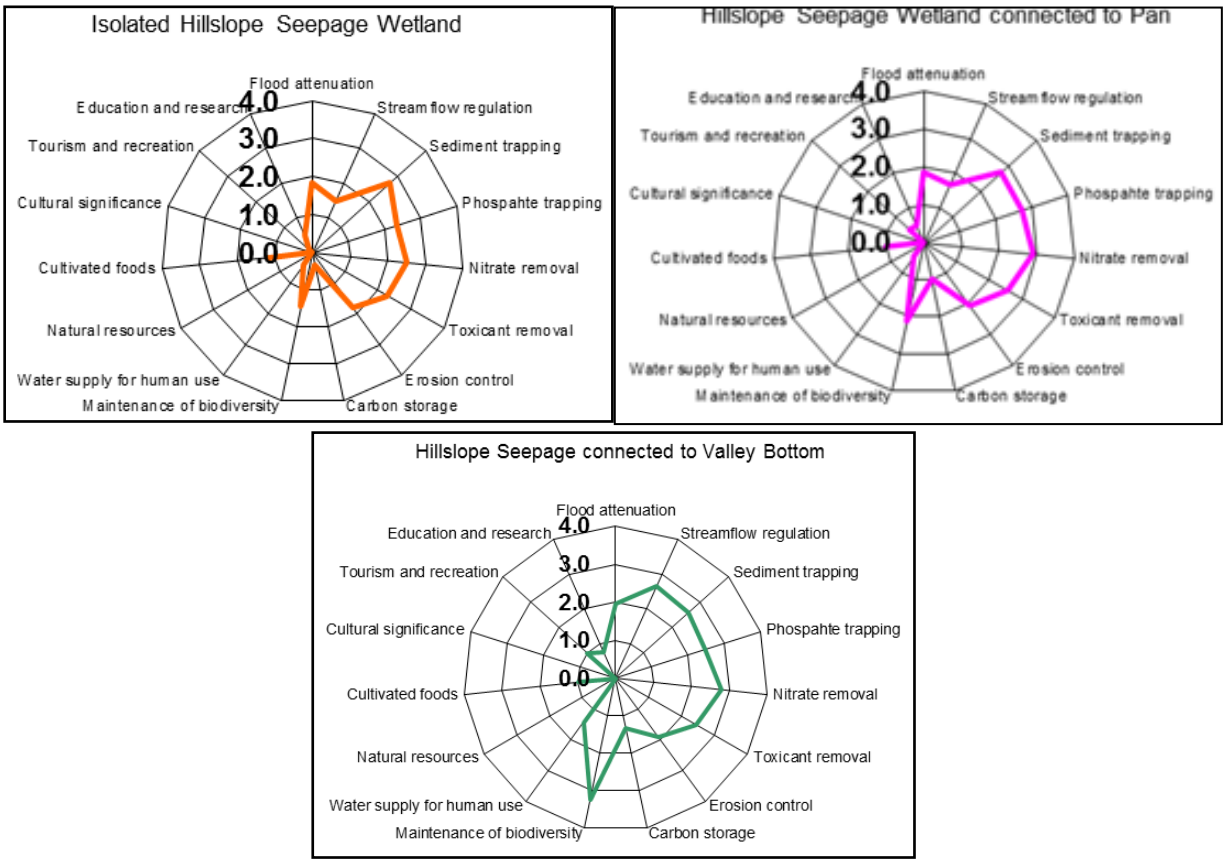


Figure 10: Radial plots showing the results of the WET-EcoServices assessment

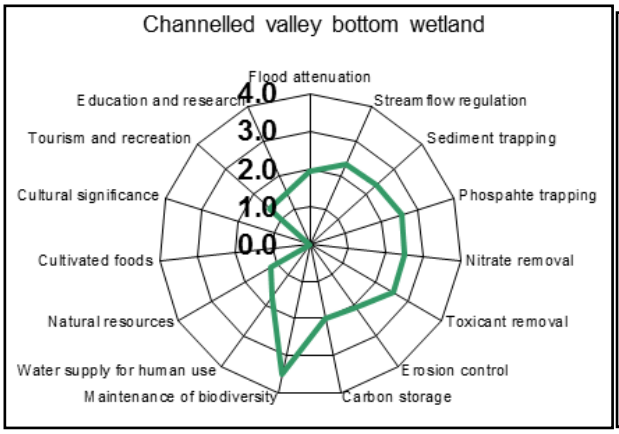
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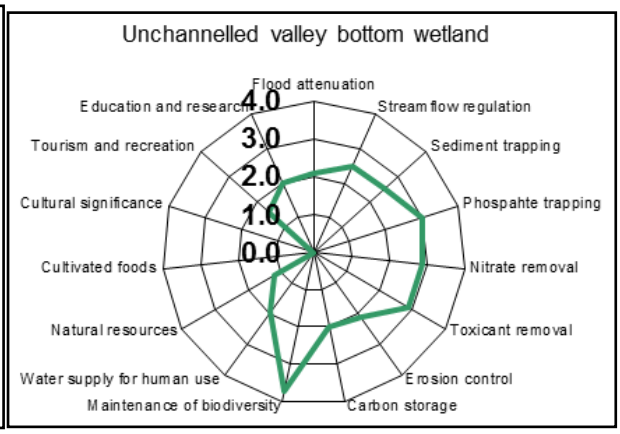
6.3.3 Valley bottom wetlands

The linear nature of valley bottom wetlands within the landscape and their connectivity to the larger drainage system provides the opportunity for these wetlands to play an important role as an ecological corridor allowing the movement and migration of fauna and flora between remaining natural areas within the landscape. Although modified in certain respects due to changes in landuse having brought about hydrological changes to these wetlands as well as vegetation transformation, the wetlands still provide a natural refuge for biodiversity, and within the study area and surroundings, the large valley bottom wetlands with associated footslope seepage wetlands represent the most significant extent of remaining natural vegetation, further enhancing their importance from a biodiversity support function.

Channelled valley bottom wetlands, through the erosion of a channel through the wetland, indicate that sediment trapping is not always an important function of these wetlands, except where regular overtopping of the channel occurs and flows spread across the full width of the wetland. Under low and medium flows, transport of sediment through, and out, of the system are more likely to be the dominant processes. Erosion may be both vertical and/or lateral and reflect the attempts of the stream to reach equilibrium with the imposed hydrology. From a functional perspective channelled valley bottom wetlands can play a role in flood attenuation when flows over top the channel bank and spread out over a greater width, with the surface roughness provided by the vegetation further slowing down the flood flows. These wetlands are considered to play only a minor role in the improvement of water quality given the short contact period between the water and the soil and vegetation within the wetland.

Un-channelled valley bottom wetlands reflect conditions where surface flow velocities are such that they do not, under existing flow conditions, have sufficient energy to transport sediment to the extent that a channel is formed. In addition to the biodiversity associated with these systems it is expected that they play an important role in retaining water in the landscape as well as in contributing to influencing water quality through for example mineralisation of rain water. These wetlands could be seen to play an important role in nutrient removal, including ammonia, through adsorption onto clay particles. The large size of the unchannelled valley bottom wetland associated with the Bronkhorstspruit suggests that this wetland plays an important role in flood attenuation – the temporary storage of flood waters within the wetland.





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Figure 11: Radial plots showing the results of the WET-EcoServices assessment

6.3.4 Pans/Depressions

Given the position of many pans within the landscape, which is usually isolated from any stream channels, the opportunity for pans to attenuate floods is fairly limited, though some run-off is stored in pans. In the cases where pans are linked to the drainage network via seep zones, the function of flood attenuation is somewhat elevated. Pans are also not considered important for sediment trapping, as many pans are formed through the removal of sediment by wind when the pan basins are dry. Some precipitation of minerals and de-nitrification is expected to take place within pans, which contributes to improving water quality. Some of the accumulated salts and nutrients can however be exported out of the system and deposited on the surrounding slopes by wind during dry periods.

An important function usually performed by pans is the support of faunal and floral biodiversity, which is enhanced by the diversity in habitat types offered by different pans. Within the study area however, the small size of most of the pans, together with their seasonal nature and the disturbed vegetation, the biodiversity support of these pans individually is expected to be limited. All of the pans are seasonal or even ephemeral systems, though the differences in pan basin size and depth, as well as catchment size and catchment soil characteristics results in pans that fill up and drain at different rates and times. As a consequence a great diversity of habitat is provided by the pans on site and in the surrounding area, and though they are all seasonal systems, the differing hydroperiods result in the fact that at least some of the pans are likely to have water at any one time. The pans when seen as a complex of pan wetlands are thus of high importance in terms of biodiversity support, whereas if each pan is assessed in isolation, its importance in terms of biodiversity is limited.

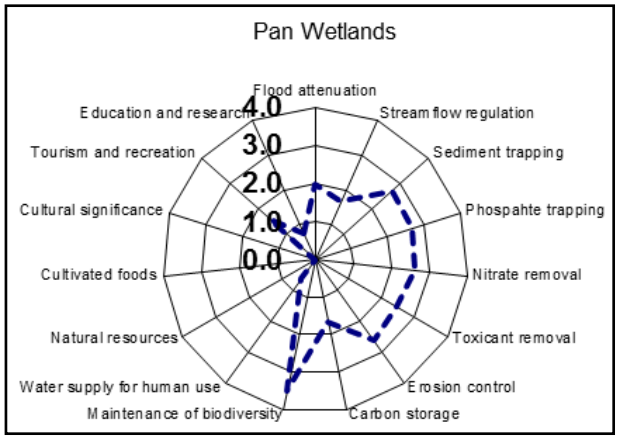


Figure 12: Radial plots showing the results of the WET-EcoServices assessment

6.4 Present Ecological Status (PES) Assessment

The wetlands on site exist within a landscape currently dominated by agricultural (cultivation, grazing) and mining activities, and these land uses have had an influence on the current extent and condition of the majority of the wetlands within the study area. Many of the wetlands and their

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catchments are currently, or have historically been, cultivated, or lie in close proximity to active mining activities, disturbances that have had an influence on the vegetation composition, geomorphology and hydrology of the wetlands.

No pristine wetlands were found to occur within the Leeuwpan Coal Mine study area, and the majority of the wetlands were found to be Moderately Modified (C). Almost 19 % of wetlands were classified as seriously modified (E), consisting mostly of hillslope seepage wetlands cultivated in their entirety, as well as a number of heavily impacted pans. The results of the Present Ecological State (PES) assessments are displayed in Figure 9 below. For specific wetlands, the overall PES category was adjusted upwards (by one level) when one of the threat categories received a score over 8 (F).

Some of the impacts encountered within the wetlands and their catchments during the site visits included:

- Cultivation (annual crops) resulting in total loss of the wetland vegetation, disturbance of the upper soil profile and increased surface runoff;
- Livestock grazing of varying intensity leading to wetland vegetation degradation and reduced species diversity;
- Irrigation dams and instream farm dams causing flow impoundment and concentration and changing the wetness regimes across the wetlands;
- Dirt and tar road crossings leading to flow concentration and erosion;
- Exotic vegetation and weed encroachment within wetlands that have been previously cultivated or disturbed causing reduced diversity and richness of the natural vegetation community;
- Trenches and berms placed to drain certain wetlands or restrict the extent of flooding across the wetlands leading to a reduction in the natural extent of the wetlands affected;
- The loss of wetland habitat to direct disturbance by mining activities;
- Altered hydrology of wetlands due to flow diversions around mining activities and altered run-off characteristics of the catchment; and
- Water quality deterioration (limited) due to mining activities.

Table 7. Results of the PES assessment.

Wetland type	PES rating				
	C	D	D/E	E	TOTAL
Channelled valley bottom		74.07		3.71	77.77
Hillslope seepage	402.64	282.46		179.05	864.15
Pan	0.21	5.96	26.39	46.75	79.31
Unchannelled valley bottom	300.21			21.56	321.78
TOTAL	**703.06**	**362.49**	**26.39**	**251.07**	**1343.01**
% of wetland area	**52.35%**	**26.99%**	**1.96%**	**18.69%**	**100.00%**

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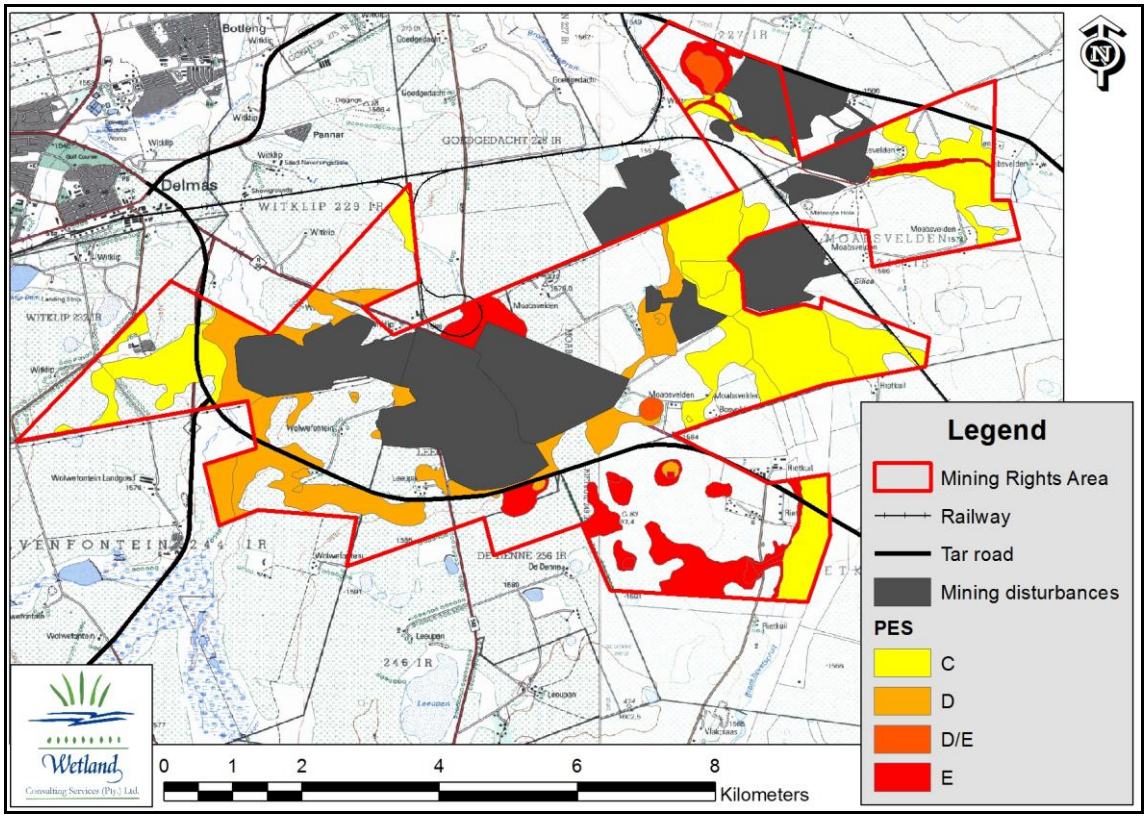


Figure 13: Results of the PES assessments for wetlands on site

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Table 8: Results of the Level 1 WET-Health assessment

HGM Unit	Wetland type	Threat Description			Combined Score	PES rating
		Hydrology	Geomorphology	Vegetation		
1	Channelled valley bottom	7.5	4.1	6	6.1	E
2	Hillslope seepage	3.5	1.8	6.5	3.9	C
3	Hillslope seepage	6	7	5	6.0	E
4	Unchannelled valley bottom	4	1.2	3.2	3.0	C
5	Hillslope seepage	3.5	1.6	3.5	3.0	C
6	Hillslope seepage	4	2.4	8.3	4.8	E
7	Hillslope seepage	4	2	4.3	3.5	C
8	Hillslope seepage	5.5	2	4.7	4.3	D
9	Hillslope seepage	3.5	1.7	3.4	3.0	C
10	Hillslope seepage	4.5	2	5.1	4.0	D
11	Hillslope seepage	4	2.4	8.3	4.8	E
13	Hillslope seepage	3.5	2.5	4.2	3.4	C
14	Hillslope seepage	4.5	2.4	7.8	4.8	D
15	Hillslope seepage	4	2.6	5.3	4.0	D
16	Channelled valley bottom	4	4.5	3.9	4.1	D
17	Hillslope seepage	4	2	4.4	3.5	C
18	Hillslope seepage	3	2	3.9	3.0	C
19	Hillslope seepage	5	2.5	6.5	4.7	D
20	Hillslope seepage	3	2.5	6.5	3.9	C

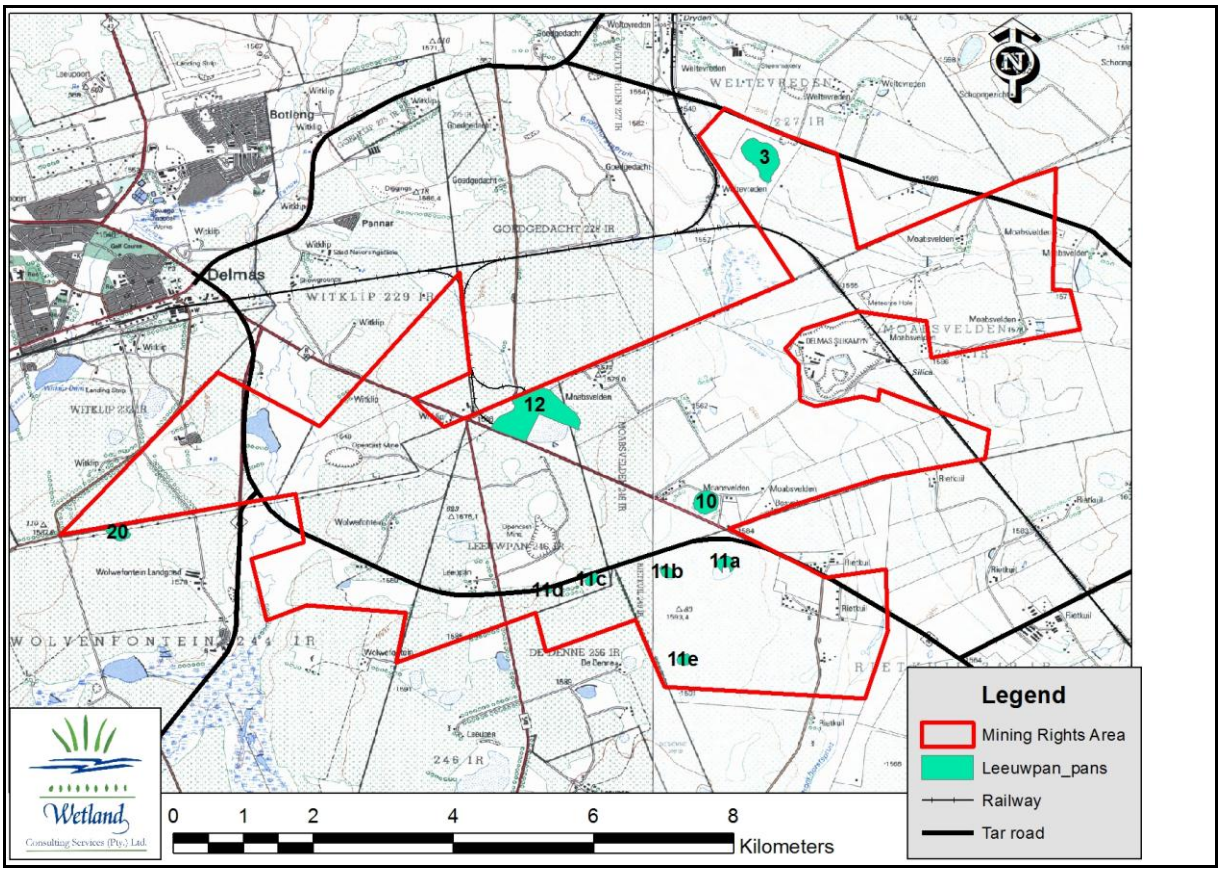


Figure 14: Map showing the numbering system used for the pans

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The Present Ecological Status of the pans on site was assessed separately, as the Level 1 WET-Health assessment does not allow for the assessment for pan wetlands. Instead, the scoring system as used in the RDM Methods developed for the DWA were used ("*Resource Directed Measures for Protection of Water Resources. Volume 4. Wetland Ecosystems*" (DWAF, 1999)).

Table 9: Results of the PES assessment for the pans on site

Wetland unit	Wetland type	PES
3	Pan	D/E
10	Pan	D/E
11a	Pan	D
11b	Pan	D/E
11c	Pan	D
11d	Pan	D
11e	Pan	E
12	Pan	E
20	Pan	C

Table 10: Table showing the rating scale used for the PES assessment

Description	Combined impact score	PES Category
Unmodified, natural.	0-0.9	A
Largely natural with few modifications. A slight change in ecosystem processes is discernable and a small loss of natural habitats and biota may have taken place.	1-1.9	B
Moderately modified. A moderate change in ecosystem processes and loss of natural habitats has taken place but the natural habitat remains predominantly intact	2-3.9	C
Largely modified. A large change in ecosystem processes and loss of natural habitat and biota and has occurred.	4-5.9	D
The change in ecosystem processes and loss of natural habitat and biota is great but some remaining natural habitat features are still recognizable.	6-7.9	E
Modifications have reached a critical level and the ecosystem processes have been modified completely with an almost complete loss of natural habitat and biota.	8 - 10	F

6.5 Ecological Importance and Sensitivity (EIS)

Ecological Importance and Sensitivity is a concept introduced in the reserve methodology to evaluate a wetland in terms of:

- Ecological Importance;
- Hydrological Functions; and
- Direct Human Benefits

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The scoring assessments for these three aspects of wetland importance and sensitivity have been based on the requirements of the NWA, the original Ecological Importance and Sensitivity assessments developed for riverine assessments (DWAF, 1999), and the work conducted by Kotze et al (2008) on the assessment of wetland ecological goods and services (the WET-EcoServices tool). Based on this methodology, an EIS assessment was undertaken for all the delineated wetlands on site, with the result discussed and illustrated below.

Ecological Importance - At a site specific scale, as well as at the local and regional scale, the wetlands (especially the large valley bottom wetlands) represent the dominant remaining extent of natural vegetation and thus play a highly significant role in biodiversity support at this level. Virtually all terrestrial habitat on site has been significantly transformed and most terrestrial areas are under cultivation, forcing species that under natural conditions might not be directly dependent on wetland habitats to frequent wetland habitats on site. Loss of the wetland habitat on site would thus result not only in the loss of wetland dependent fauna, but also impact significantly on terrestrial faunal species that remain on site. At the National and International level, the importance of many of the smaller hillslope seepage wetlands and pans in biodiversity support is limited due to the disturbances that have already taken place within these systems, the generally low species richness of wetlands compared to other ecosystems (e.g. terrestrial grassland), and the limited number of Red Data species likely to occur on site.

Hydrological Functions – The hydrological functions of the wetlands are discussed under the functional assessment above. To summarise, the hillslope seepage wetlands are considered to be most valuable in terms of water quality maintenance, while the valley bottom wetlands, specifically the large unchannelled valley bottom wetland of the Bronkhorstspruit, are also important in terms of flood attenuation and sediment trapping.

Direct Human Benefits – Some of the wetlands on site are extensively used for crop cultivation (e.g. hillslope seepage wetlands), while others (e.g. the large valley bottom wetlands and uncultivated seepage wetlands) are used for livestock grazing. Dams within some of the wetlands also provide drinking water for livestock, and limited use for irrigation. No known cultural practices take place within the wetlands on site.

The two large valley bottom wetland systems on site, the Bronkhorstspruit and its tributary in the west of the study area, are considered to be of **High (B)** ecological importance and sensitivity, mostly due to the role they play in biodiversity support and as an ecological corridor. The remainder of the wetlands are either of Moderate (C) or Low (D) ecological importance, related mostly to the level of disturbance these system have undergone.

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Table 11: Results of the EIS assessment

HGM Unit	Wetland type	EIS rating
1	Channelled valley bottom	C
2	Hillslope seepage	C
3	Pan & Hillslope seepage	D
4	Unchannelled valley bottom	B
5	Hillslope seepage	C
6	Hillslope seepage	D
7	Hillslope seepage	C
8	Hillslope seepage	D
9	Hillslope seepage	C
10	Pan & Hillslope seepage	D
11	Pans & Hillslope seepage	C/D
12	Pan	D
13	Hillslope seepage	C
14	Hillslope seepage	D
15	Hillslope seepage	C
16	Channelled valley bottom	B
17	Hillslope seepage	C
18	Hillslope seepage	D
19	Hillslope seepage	D
20	Pan & Hillslope seepage	C

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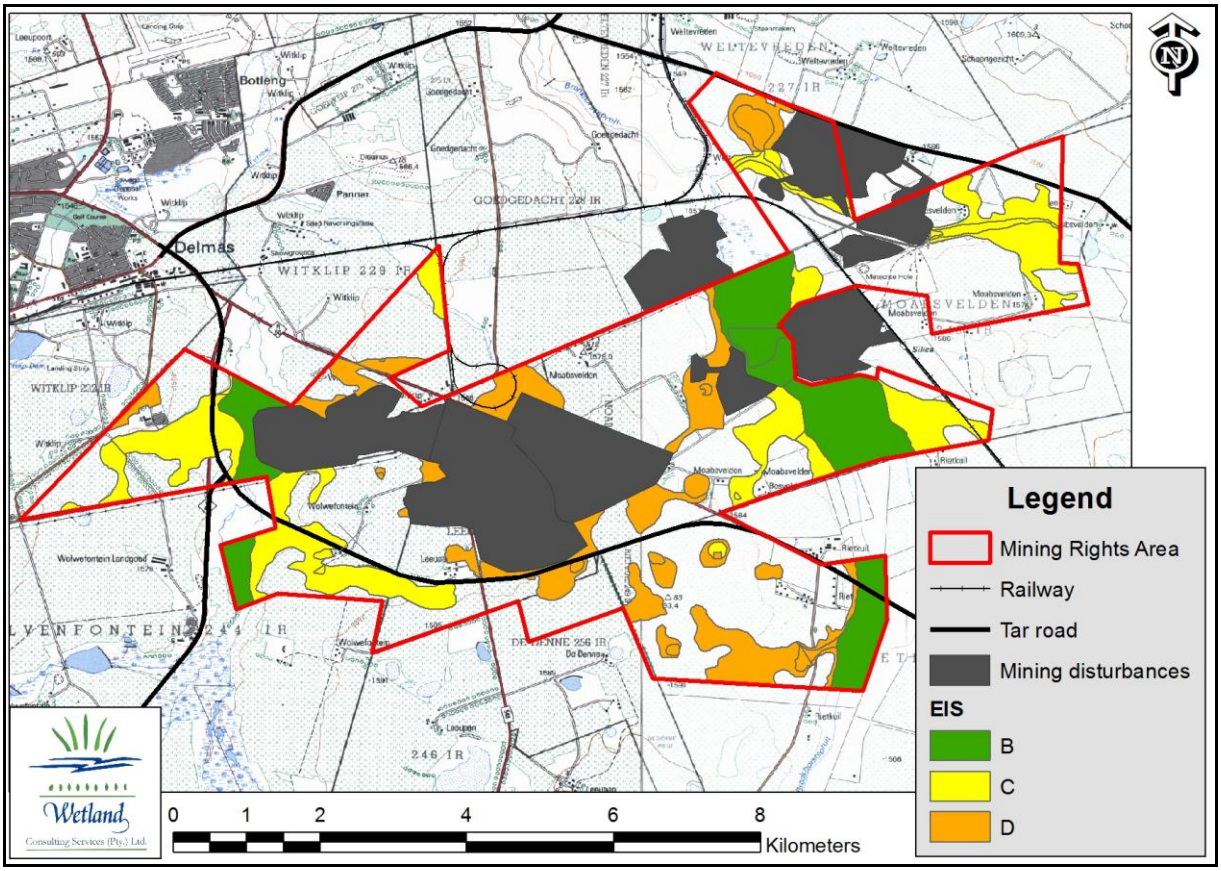


Figure 15: Map showing the results of the EIS assessment

Table 12: Scoring system used for the EIS assessment

Ecological Importance and Sensitivity categories	Range of Median	Ecological Management Class
Very high Wetlands that are considered ecologically important and sensitive on a national or even international level. The biodiversity of these wetlands is usually very sensitive to flow and habitat modifications. They play a major role in moderating the quantity and quality of water of major rivers.	>3 and <=4	A
High Wetlands that are considered to be ecologically important and sensitive. The biodiversity of these wetlands may be sensitive to flow and habitat modifications. They play a role in moderating the quantity and quality of water of major rivers.	>2 and <=3	B
Moderate Wetlands that are considered to be ecologically important and sensitive on a provincial or local scale. The biodiversity of these wetlands is not usually sensitive to flow and habitat modifications. They play a small role in moderating the quantity and quality of water of major rivers.	>1 and <=2	C
Low/marginal Wetlands that is not ecologically important and sensitive at any scale. The biodiversity of these wetlands is ubiquitous and not sensitive to flow and habitat modifications. They play an insignificant role in moderating the quantity and quality of water of major rivers.	>0 and <=1	D

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7. IMPACT ASSESSMENT

7.1 Project Description

This impact assessment is prepared as part of the EIA/EMP consolidation project for Leeuwpan Coal Mine. As such it deals with both existing activities as well as proposed new activities.

Proposed new activities include the establishment and operation of a new opencast pit, as well as the required operational infrastructure:

- DMS (Dense Media Separation) Plant;
- Jig Plant;
- Oil and Wash Bay / -extension;
- Weighbridges;
- Change houses / ablution facilities;
- Office buildings / -extensions;
- Pipelines;
- Clean and Dirty water systems;
- Conveyor routes; and
- Additional product stockpiles at the rail loop.

The impacts expected due to the proposed activities have been grouped into 5 phases:

- Pre-construction Phase;
- Construction Phase;
- Operational Phase;
- Decommissioning & Closure Phase; and
- Cumulative Impacts.

The proposed activities largely consist of an expansion of existing activities on site, rather than the establishment of completely new activities, i.e. opencast coal mining already takes place on site, as does coal processing, stockpiling and transport. As such, the impacts of the existing activities, which are all in the operational phase (and in some cases the decommissioning and closure phases) will be addressed as part of the impacts assessed for the operational phase and decommissioning and closure phase of the new proposed activities.

In order to allow for more detail and activity specific assessment of impacts, the activities have been grouped into the following:

- Opencast coal mining;
- Conveyors & roads;
- Other linear infrastructure (powerlines, pipelines etc.);
- Surface infrastructure (Plant area, product stockpiles, wash bays, offices, diesel storage etc.); and
- Water management infrastructure.

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A brief summary of expected impacts and the recommended mitigation measures is provided in the following sections. For the full, detailed impact assessment with significance ratings, please refer to the Excel Spreadsheets accompanying this report, and reproduced in Appendix 3.

7.2 Impact Assessment Methodology

Status of Impact	
+: Positive (A benefit to the receiving environment)	
N: Neutral (No cost or benefit to the receiving environment)	
-: Negative (A cost to the receiving environment)	
Magnitude:=M	***Duration:=D***
10: Very high/don't know	5: Permanent
8: High	4: Long-term (ceases with the operational life)
6: Moderate	3: Medium-term (5-15 years)
4: Low	2: Short-term (0-5 years)
2: Minor	1: Immediate
0: Not applicable/none/negligible	0: Not applicable/none/negligible
Scale:=S	***Probability:=P***
5: International	5: Definite/don't know
4: National	4: Highly probable
3: Regional	3: Medium probability
2: Local	2: Low probability
1: Site only	1: Improbable
0: Not applicable/none/negligible	0: Not applicable/none/negligible

Once the factors had been ranked for each impact, the environmental significance of each impact could be assessed by applying the SP formula. The SP formula can be described as:

Significance = (**magnitude** + **duration** + **extent**) x **probability**

The maximum value of significance points (SP) is 100. Environmental effects could therefore be rated as either high (H), moderate (M), or low (L) significance on the following basis:

Significance	*Environmental Significance Points*	*Colour Code*
High (positive)	>60	H
Medium (positive)	30 to 60	M
Low (positive)	<30	L
Neutral	0	N
Low (negative)	>-30	L
Medium (negative)	-30 to -60	M
High (negative)	<-60	H

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7.3 Opencast Coal Mining

Figure 16 shows the proposed opencast pits in relation to the delineated wetlands. 68.4 ha of wetlands occur within the proposed 272.4 ha opencast mining area, implying that 25 % of the opencast footprint is classified as wetland. Two hydro-geomorphic wetland types were identified, namely hillslope seepage wetlands (54.8 ha) and pan wetlands (12.4 ha). Two dams were also identified, one with a hillslope seepage wetland, and the second an irrigation dam constructed within a pan basin.

The hillslope seepage wetlands have been extensively impacted by cultivation within the wetland boundaries, with all hillslope seepage wetlands within the proposed southern opencast pit (south of the R50 tar road) being currently cultivated in their entirety. The northern seepage wetlands have been extensively impacted by cultivation along their perimeters, though the wetlands themselves have not been directly cultivated.

The pans have also been significantly impacted by activities associated with irrigation. The northern pan appears to be used as an irrigation dam that is being used for the temporary storage of groundwater prior to use of this water for irrigation (centre-pivot). This has altered the pan from what is assumed to have been a shallow, grassed, seasonal system (supported by observations on historical imagery) to a permanent, open water pan lined by *Salix babylonica* and *Phragmites australis*. Regarding the southern two pans, the eastern pan has had a rectangular irrigation dam constructed within the pan basin, as well as a farm road through the pan, while the western pan lies partially within the path of a centre-pivot irrigation system, and the perimeter is entirely cultivated.

Should the proposed opencast mining activities proceed as currently proposed, the wetlands within the mining footprint (see Figure 16) will be completely and permanently destroyed. Opencast mining permanently alters the movement of water through the landscape through its impact on geological strata and soil structure, and thus impacts on the opportunity for wetlands to reform in the post mining landscape.

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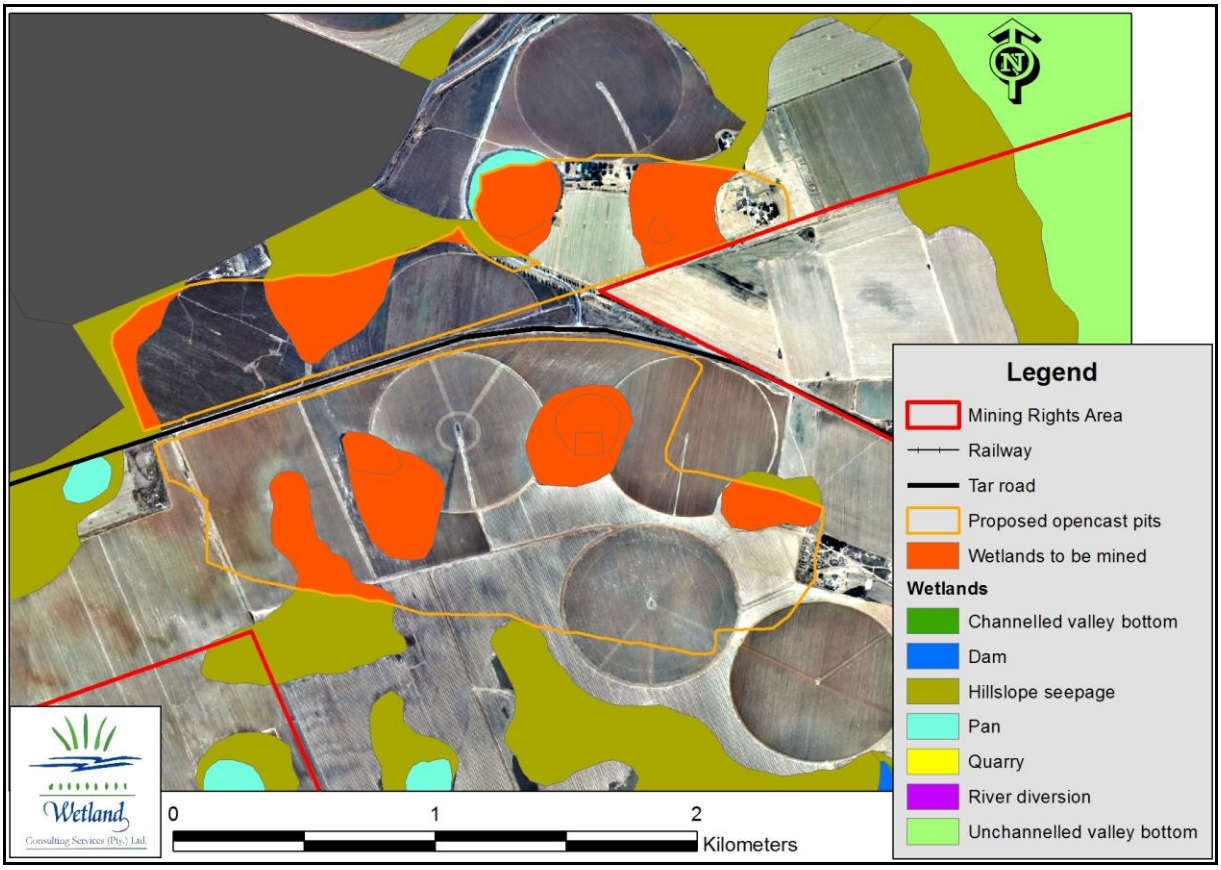


Figure 16: Delineated wetlands within the proposed opencast pits. Wetlands to be mined through have been highlighted in orange

Existing (already authorised) opencast operations will also continue on site, with approximately 100ha cleared be annum. All wetlands located within the footprints of these already authorised opencast mines will also be lost.

The significance of the loss of the wetlands within the proposed opencast footprints is expected to be as follows:

1. **Loss of biodiversity** – Wetlands support habitats that differ from the surrounding terrestrial habitats, and thus support a unique assemblage of species and are important in terms of biodiversity support. The disturbance to the wetlands within the opencast footprint, specifically the extensive cultivation of the hillslope seepage wetlands, has significantly reduced the biodiversity support function of the wetlands on site. The pans, though heavily impacted, still play a more important role in biodiversity support, specifically the south eastern pan where a rich birdlife was observed at the time of the survey, including a number of Greater Flamingo (listed as Near Threatened). The loss of a single pan, viewed in isolation, is unlikely to impact significantly on biodiversity at a regional scale. However, given the large number of mining applications within the area, the cumulative impact of wetland loss does need to be considered.
2. **Decreased water yield to downstream wetlands** – Pans, being inwardly draining, do not generally contribute significant water volumes to downstream wetland systems, and the loss of the pans is not expected to impact significantly on water yield to adjacent wetlands. Hillslope seepage wetlands are more typically considered to play a role in flow regulation, i.e. the temporary storage and slow release of flows to downslope wetlands and water courses. The hillslope seepage wetlands on site however, are characterised by generally shallow soils overlying ferricrete, limiting the volumes of water these systems can store.

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Lateral movement of water through the seepage wetlands is also expected to be minimal, further decreasing the importance of these wetlands in contributing flow to downstream wetlands. Most of the water supporting the hillslope seepage wetlands on site is expected to be lost to evapotranspiration. A possible exception is the north eastern hillslope seepage wetland, though the increased saturation of this wetland could be a result of increased seepage of water out of the pan due to the storage of groundwater in the pan. Note however that no modelling was undertaken to verify these assumptions.

3. **Loss of wetland ecosystem functions** – Wetlands are generally considered to perform a number of ecosystem services, ranging from flood attenuation and water quality enhancement, to biodiversity support and direct human benefits (e.g. provision of natural resources). In the case of the wetlands on site, the most important function performed by the pans is that of biodiversity support (addressed under point 1 above). The hillslope seepage wetlands are considered to be most important in terms of water quality maintenance, though the limited role they are expected to play in discharging flow to downstream wetlands also limits the significance of this function. Under natural conditions, they would also have been important in terms of biodiversity support, but currently only play a role in supporting productivity, i.e. crop cultivation.
4. **Deterioration in water quality** – Post-mining, the backfilled voids are likely to fill with water and start decanting. Decanting water is likely to be acidic as well as metal (e.g. Aluminium and Iron) and sulphate rich, resulting in significant deterioration of water quality within the Bronkhorstspruit to the east of the opencast pits. Currently, due to the absence of mining activities within the Bronkhorstspruit upstream of the R50 road crossing, the water quality at this point within the Bronkhorstspruit is still good, though agricultural impacts are evident.

The following impacts are expected due to the proposed opencast mining activities:

Pre-construction & Construction:

- Loss and disturbance of wetland habitat;
- Increased surface runoff from bare soil areas;
- Increased sediment transport into wetlands;
- Decreased water make to downslope wetlands

7.3.1 Loss and disturbance of wetland habitat

As indicated above, 68.4 ha of wetland habitat will be directly destroyed by the proposed opencast mining activities.

Construction activities, if not strictly controlled, will also result in additional disturbances to the wetland vegetation and habitat on site, through for example injudicious driving in the wetland area, fire, or temporary stockpiling of material in the wetland area. Such disturbances can lead to increased erosion in the wetlands (e.g. preferential flow paths created by vehicle tracks), displacement of wetland fauna, changes in wetland vegetation and invasion by alien vegetation. Blasting activities are also likely to result in disturbance and possibly displacement to wetland fauna.

Mitigation

The loss of wetland habitat could only be avoided if the layout and/or location of the proposed opencast pit was adjusted. The location of the pit is however limited by the location of the coal resource, i.e. you can only mine where the coal is located. Adjusting the pit to exclude all wetland

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areas would also likely render the proposed mining non-feasible. The loss of wetland habitat is thus inevitable if the coal resource is to be mined.

The wetlands falling within the proposed opencast footprint have however already been heavily impacted by agricultural activities. The main function of these wetlands in their natural condition is expected to have been biodiversity support, though this has been significantly compromised by the extensive cultivation of the hillslope seepage wetlands within the proposed opencast footprint.

A consideration should be given to wetland offsets as a means of mitigating the loss of wetland habitat. Such an offset would need to be informed by the recently published SANBI Guidelines on wetland offsets.

All wetland areas located adjacent to mining areas should be fenced off prior to commencement of vegetation clearing activities on site so as to prevent access to construction machinery and personnel. In addition, all wetland areas should be clearly marked and demarcated as such to alert construction staff on site. All construction staff should also be educated on the importance and sensitivity of the wetland systems on site. This should form part of the induction process.

No stockpiling of material may take place within the wetland areas and temporary construction camps and infrastructure should also be located away from these areas, with a minimum buffer of 50m maintained from delineated wetland boundaries. Regular cleaning up of the wetland areas should be undertaken to remove litter, while an alien vegetation management plan should be drawn up by the Environmental Co-ordinator and implemented. Regular removal of invasive alien species should be undertaken. This should extend right through to the decommissioning and closure phase of the project

7.3.2 Increased surface runoff from bare soil areas

Stripping of vegetation will increase volumes and velocities of surface runoff generated from the affected area, increasing erosion risk within downslope wetlands. Soil compaction due to movement of machinery during construction will further increase runoff, while vehicle ruts and tracks resulting from construction activity could provide preferential flow paths that lead to flow concentration, again increasing erosion risk.

Mitigation

The footprint of vegetation clearing should be kept as small as possible. Vegetation clearing should be phased so as to limit the extent of bare soil areas at any one time. A shallow berm or other sediment barrier should be constructed downslope of the proposed opencast pits to attenuate/slow down sheet flow and create a depositional environment to trap sediments. Concentrated runoff from cleared areas should be avoided. Any preferential flows paths that do develop should be plugged as soon as possible.

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7.3.3 Increased sediment transport into wetlands

Bare soil areas resulting from vegetation clearing and soils tripping will provide extensive sediment sources delivering increased sediment loads to downslope wetlands. Transported sediments are likely to deposit in the receiving wetlands, leading to changes in vegetation and habitat.

Mitigation

Vegetation clearing and earthworks should be limited to as small an area as possible, preferably no larger than the direct footprint of the proposed development. Bare soil areas falling outside the direct footprint should be landscaped to the original landscape profile and re-vegetated as soon as possible. Hydroseeding with a mix of species (see Section 8.2 below) should be done with regular monitoring to ensure 70% cover in revegetated areas within 3 months. Where practically possible, the major earthworks should be undertaken during the dry season (roughly from June to September) to limit erosion due to rainfall runoff. A shallow berm should be constructed between the proposed opencast footprint and the downslope wetlands to prevent sediment rich runoff from the construction site entering the wetlands. These berms should thus be constructed prior to the commencement of construction on the opencast pit.

7.3.4 Decreased water make to downslope wetlands

Through excluding a portion of the wetlands catchment, and permanently altering the movement of water through the landscape within the opencast footprints, it is likely that water flow to downslope wetlands will be cut-off. In the case of the proposed opencast pit, the decrease in water make is likely to be limited, as the wetlands on site (pans and hillslope seepage wetlands) are not thought to contribute significantly to flow in downslope wetlands, with the north eastern seepage wetland (see Figure 16 above) likely to make the most significant contribution, though this could be influenced by the storage of groundwater in the upslope pan.

No modelling was however done to determine the flow contributions of the catchments to the wetlands, and the wetlands to the downslope water resources. It is likely that the DWA, based on experience gained from other recently completed projects, will require modelling to quantify flow contributions from the catchments to the wetlands. This will need to be done by an eco-hydrologist and could be undertaken as part of a wetland reserve study, or as a standalone study to supply additional information to the WULA.

Operation:

The operational phase will involve the progressive development of the opencast pit; the impacts will be largely the same as for the construction phase of the opencast pits. For completeness, the impacts and recommended mitigation measures are repeated below.

- Loss and disturbance of wetland habitat;
- Increased surface runoff from bare soil areas; and
- Increased sediment transport into wetlands.
- Water quality deterioration.

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7.3.5 Loss and disturbance of wetland habitat

As indicated above, 68.4 ha of wetland habitat will be directly destroyed by the proposed opencast mining activities.

Opencast mining activities, if not strictly controlled, will also result in additional disturbances to the wetland vegetation and habitat on site, through for example injudicious driving in the wetland area, fire, or temporary stockpiling of material in the wetland area. Such disturbances can lead to increased erosion in the wetlands (e.g. preferential flow paths created by vehicle tracks), displacement of wetland fauna, changes in wetland vegetation and invasion by alien vegetation. Blasting activities are also likely to result in disturbance and possibly displacement to wetland fauna.

Mitigation

The loss of wetland habitat could only be avoided if the layout and/or location of the proposed opencast pit were adjusted. The location of the pit is however limited by the location of the coal resource, i.e. you can only mine where the coal is located. Adjusting the pit to exclude all wetland areas would also likely render the proposed mining non-feasible. The loss of wetland habitat is thus inevitable if the coal resource is to be mined.

The wetlands falling within the proposed opencast footprint have however already been heavily impacted by agricultural activities. The main function of these wetlands in their natural condition is expected to have been biodiversity support, though this has been significantly compromised by the extensive cultivation of the hillslope seepage wetlands within the proposed opencast footprint.

All wetland areas located adjacent to mining areas should be fenced off prior to commencement of vegetation clearing activities on site so as to prevent access to construction machinery and personnel. In addition, all wetland areas should be clearly marked and demarcated as such to alert construction staff on site. All construction staff should also be educated on the importance and sensitivity of the wetland systems on site. This should form part of the induction process.

No stockpiling of material may take place within the wetland areas and temporary construction camps and infrastructure should also be located away from these areas. Regular cleaning up of the wetland areas should be undertaken to remove litter, while an alien vegetation management plan should be drawn up by the Environmental Coordinator. Regular removal of invasive alien species should be undertaken. This should extend right through to the decommissioning and closure phase of the project

7.3.6 Increased surface runoff from bare soil areas

Stripping of vegetation will increase volumes and velocities of surface runoff generated from the affected area, increasing erosion risk within downslope wetlands. Soil compaction due to movement of machinery during construction will further increase runoff, while vehicle ruts and tracks resulting from vegetation clearing and soil stripping activity could provide preferential flow paths that lead to flow concentration, again increasing erosion risk.

Mitigation

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The footprint of vegetation clearing should be kept as small as possible. Vegetation clearing should be phased so as to limit the extent of bare soil areas at any one time. A shallow berm or other sediment barrier should be constructed downslope of the proposed opencast pits to attenuate/slow down sheet flow and create a depositional environment to trap sediments. Concentrated runoff from cleared areas should be avoided. Any preferential flows paths that do develop should be plugged as soon as possible.

7.3.7 Increased sediment transport into wetlands

Bare soil areas resulting from vegetation clearing and soils tripping will provide extensive sediment sources delivering increased sediment loads to downslope wetlands. Transported sediments are likely to deposit in the receiving wetlands, leading to changes in vegetation and habitat.

Mitigation

Vegetation clearing, topsoil / wetland soil stripping (where required) and earthworks should be limited to as small an area as possible, preferably no larger than the direct footprint of the proposed development. Bare soil areas falling outside the direct footprint should be landscaped to the original landscape profile and re-vegetated as soon as possible. Hydroseeding with a mix of species (see Section 8.2 below) should be done with regular monitoring to ensure 70% cover in revegetated areas within 3 months. Where practically possible, the major earthworks should be undertaken during the dry season (roughly from June to September) to limit erosion due to rainfall runoff. A shallow berm should be constructed between the proposed opencast footprint and the downslope wetlands to prevent sediment rich runoff from the construction site entering the wetlands. These berms should thus be constructed prior to the commencement of construction on the opencast pit.

7.3.8 Water quality deterioration

As part of supporting activities for the opencast mining activities, numerous hazardous and potentially polluting substances will be utilised and possibly temporarily stored on site, including for example diesel and oil. Spillages and leaks of these hydrocarbons could result in the deterioration of water quality should they enter the adjacent wetland areas via surface runoff.

Mitigation

All hazardous substances should be stored on impervious surfaces, outside any wetland areas, that allow for the containment of spills and leakages (e.g. bunded areas). Should spills occur, these should be reported to the ECO. Larger spills will require the appointment of specialist clean-up teams to rehabilitate the affected area. No hazardous materials may be stockpiled in any wetland area on site.

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Decommissioning & Closure:

- Altered hydrology;
- Water quality deterioration;
- Increased sediment transport into wetlands; and
- Increase in alien vegetation.

7.3.9 Altered hydrology

Opencast mining permanently alters the movement of water through the landscape through its impacts on geological strata and soils. Compared to the pre-mining landscape, the rehabilitated opencast pit will have significantly increased infiltration to groundwater and increased surface runoff. Typically the rehabilitated opencast areas lack the shallow perched water table that characterised the pre-mining landscape.

The implications of these changes are that no wetlands are likely to reform on the rehabilitated opencast areas, and that the remaining wetlands downslope of these areas will be faced with altered runoff characteristics from their catchment. Typically, surface runoff volumes and velocities are expected to increase, leading to increases in flood peaks and erosive energy, while subsurface inputs are expected to decrease, reducing low flows and increasing seasonality.

Mitigation

Opencast mining permanently alters the movement of water through the landscape. Mitigation options in this regard are thus limited. However, the rehabilitation of the opencast pits should ensure sufficient compaction of replaced spoils to limit ingress of surface water. A sufficient topsoil layer, based on the desired end landuse as indicated in the closure plan, should also be replaced. If excess top soil is available, consideration should be given to increase the top soil depth in valley bottom areas/low points within the rehabilitated landscape to encourage the formation of wetlands in these areas.

7.3.10 Deteriorating water quality

Post-mining, the backfilled opencast pits are likely to fill with water as groundwater levels rebound. Eventually the pits are likely to start decanting. Decanting water is likely to be acidic as well as metal and sulphate rich. Given the location of the proposed opencast pit, decant is likely to enter either directly or indirectly into the Bronkhorstspruit wetland system if left unmitigated.

Mitigation

Consideration should be given to the installation of a water treatment plant. Decanting water should be capture/pumped out of the void to prevent the contaminated water entering the Bronkhorstspruit. Following treatment, the water could then be discharge back into the environment, ideally as a combination of direct discharge into the wetlands and irrigation into the wetland catchments, if areas suitable for irrigation are found within the direct vicinity.

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7.3.11 Increased sediment transport into wetlands

The rehabilitated mine impacted areas will be susceptible to erosion following rehabilitation, especially in areas that are sparsely vegetated or not vegetated at all. This will result in increased sediment loads in the downslope wetlands, leading to deteriorating water quality (increased turbidity and TSS) and changes in the aquatic fauna. Changes in wetland vegetation can also occur as sediment loving plants (e.g. *Phragmites australis*) become dominant.

Mitigation

All disturbed areas should be landscape to approximate the natural landscape profile, but should avoid steep slopes and concentrated run-off. Compacted soils should be ripped and scarified. The rehabilitated areas should be re-vegetated as soon as possible following completion of the earthworks to minimise erosion. Regular long-term follow up of rehabilitated areas will be required to ensure the successful establishment of vegetation and to survey for any erosion damage on site. Erosion damage should be repaired immediately. The recommendations contained within the specialist vegetation and soils reports should be fully implemented to ensure successful rehabilitation.

7.3.12 Increase in alien vegetation

Following the completion of decommissioning, the recently placed and disturbed soils will be susceptible to invasion by alien vegetation, e.g. *Acacia mearnsii* (black wattle). These alien species could spread to the adjacent wetland areas and result in decreased flows, increased erosion and decreased biodiversity in these systems.

Mitigation

The alien vegetation management plan compiled by an ecologist during the construction/operational phase of the mine should be kept in place for several years following mine closure (minimum of ten years). All species of alien invasive vegetation should be controlled and removed from site. No spread of alien vegetation into any wetlands or adjacent properties should be allowed.

Cumulative:

- Wetland loss – the proposed project will contribute to the significant wetland loss occurring within the Upper Olifants River due to opencast mining activities. Several thousand hectares of land have already been permanently altered by mining activities, including the permanent loss of the wetlands naturally occurring in those areas.
- Water Quality Deterioration – the proposed opencast mines will likely decant acidic mine water post-closure which will contribute to the serious water quality deterioration that has already taken place within the Upper Olifants River Catchment. In fact, the Integrated Water Resource Management Plan for the Upper and Middle Olifants Catchment states that there is no more assimilative capacity within the Loskop Dam catchment if the resource water quality objectives are to be met. The report states further that salinity loads within the

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Olifants River will need to be reduced in order to meet the RWQO. The impact of coal mining is thought to a large part to be responsible for this water quality deterioration.

7.4 Conveyors and roads

The proposed new conveyor will run from the new plant area towards the expanded product stockpiles adjacent to the rail loop. The entire conveyor route runs over previously and currently disturbed mining land, with most of the conveyor route located on previously opencast land, and no natural wetland areas occur along the route.

As such, no impacts to wetlands are expected from the construction activities associated with the conveyor belt and associated service road. The impact assessment thus only addresses impacts associated with the operation of conveyors.

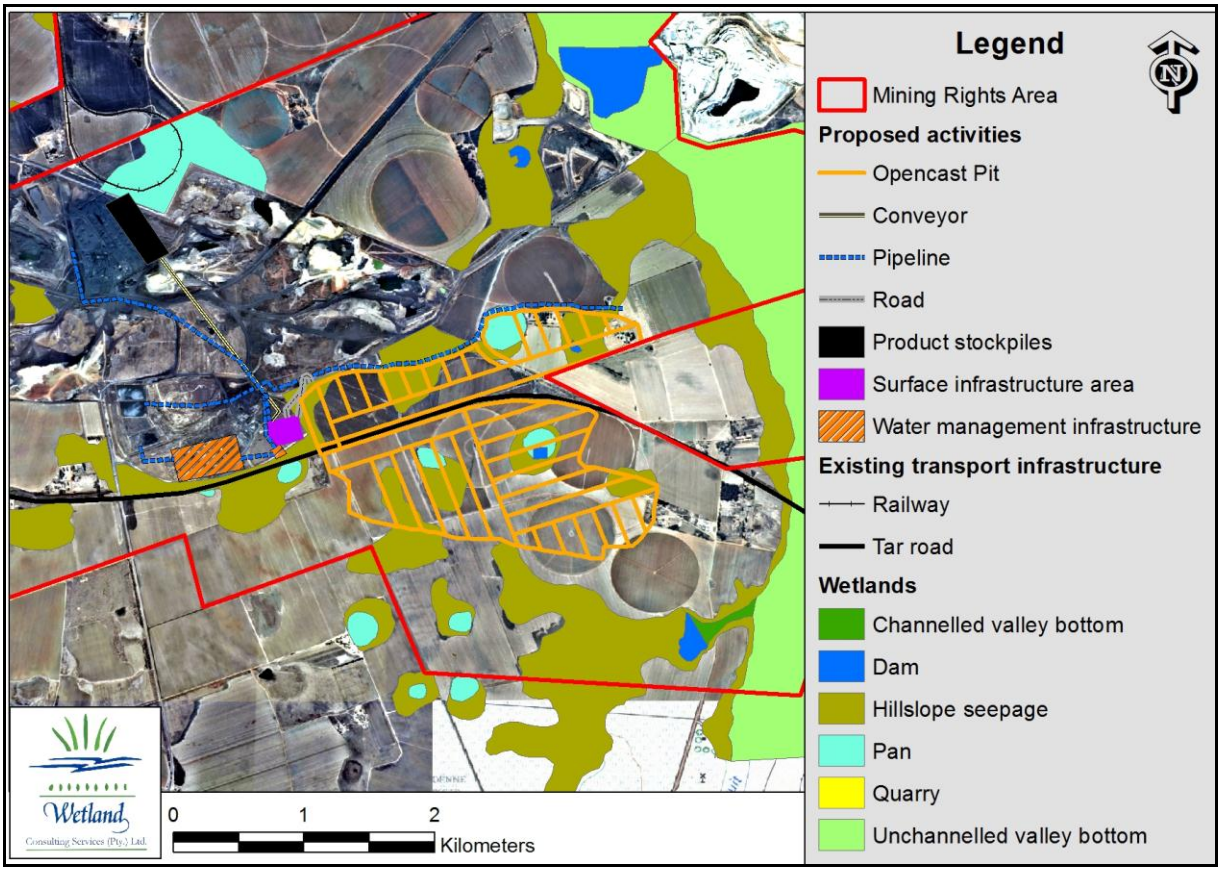


Figure 17. Map showing the proposed surface infrastructure and mining areas.

The only new haul roads indicated on the provided mine plan are as indicated in Figure 17. The impact of the construction phase for these roads has been assessed below.

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Pre-construction & Construction:

7.4.1 Loss and disturbance of wetland habitat

The wetland habitat located directly within the footprint of any proposed crossings will be lost, while construction activities will result in the disturbance of surrounding wetland habitat. Movement of machinery through wetlands will trample vegetation, disturb soils and result in the formation of ruts that could concentrate flows and encourage erosion. Disturbed areas will also be vulnerable to invasion by alien vegetation.

Mitigation

- The construction servitude for roads should be kept as small as possible and should be clearly demarcated in the field;
- No activities should take place outside the construction servitude and no materials may be stockpiled in the wetland area;
- Construction should be undertaken in the dry season; and
- Following completion of construction activities, all disturbed areas should be rehabilitated – where required this will require ripping, scarifying and landscaping of the soil to the natural landscape profile and to encourage vegetation re-establishment.

7.4.2 Increased erosion and sedimentation

Disturbances to the wetland during construction will increase the risk of erosion. This will be exacerbated if construction is undertaken with flows in the wetland that will then need to be diverted around the construction workings and will likely result in flow concentration.

Sediments are also likely to washed into the wetland from construction activities of the road approaching and departing the wetland crossing. Sediments deposited within the wetland will change the vegetation of the wetland, with species such as *Typha capensis* likely to establish in depositional areas.

Mitigation

- The construction servitude for the road should be kept as small as possible and should be clearly demarcated in the field;
- Construction should be undertaken in the dry season;
- No activities should take place outside the construction servitude and no materials may be stockpiled in the wetland area;
- Hay bales should be put along the downslope edge of the conveyor servitude to trap any sediments that may be washed off the construction area;
- Stormwater from the approach and departure roads to the crossing should be diverted off the road and into adjacent grassland at regular intervals, already during the construction phase to prevent sediment from these areas being washed into the wetland; and

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- Following completion of construction activities, all disturbed areas should be rehabilitated – where required this will require ripping, scarifying and landscaping of the soil to the natural landscape profile and to encourage vegetation re-establishment.

Operation:

- Deteriorating water quality due to coal spillages;
- Stormwater discharge into wetlands; and
- Altered flows in the wetland.

7.4.3 Deteriorating Water Quality due to Coal Spillages

Coal spillages and coal dust from the conveyor and especially belt transfer areas along the conveyor can lead to pollution of wetlands and other water resources along the conveyor route. However, coal spillages from coal transported via conveyor are generally considered to be less than spillages from coal trucks. No wetlands occur along the conveyor route.

Mitigation

Gantries should be used for all wetland crossings to minimise spills and dust. Should larger spillages occur due to malfunctioning of the conveyor or for any other reason, clean up of the spillages should be undertaken as soon as possible following the event and should be done under supervision of a wetland specialist. The movements of vehicles and machinery into wetland areas during clean-up operations should be limited and strictly controlled; a wetland specialist should thus be consulted if the spills are of such a nature that vehicles and/or machinery need to enter wetland areas.

Regular inspections of the entire conveyor route should be undertaken. No belt transfers are to be located within the wetland areas on site. Where belt transfers are located in close proximity to wetland areas a small, shallow berm should be constructed between the belt transfer site and the wetland area to prevent direct run-off of storm water from the belt transfer site into the valley bottom wetland

7.4.4 Stormwater discharge into the wetlands

Roads will generate stormwater runoff during rain events that will likely be discharged into the wetland areas. Concentrated, point source discharges will lead to erosion, while stormwater is also likely to carry hydrocarbon pollutants into the wetland.

Mitigation

Stormwater should not be allowed to accumulate on the road surface. Regular discharge points into adjacent grassland should be provided. Discharge points should be protected against erosion. No stormwater should be discharged directly into the wetland.

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7.4.5 Altered flows in the wetland

Construction of the road across the wetland could lead to the impoundment of flows upslope of the wetland, extending saturation of the area and encouraging sediment deposition. This will lead to changes in the wetland vegetation, most likely resulting in the formation of a *Typha capensis* reed bed.

The culverts could further lead to concentration of flows, resulting in higher velocity flows with greater erosive energy that could lead to channel incision above and below the crossing point. Channel incision will lower the local water table and lead to partial drying out of the wetland verges and terrrestrialisation of the vegetation.

Mitigation

Any proposed bridge structures should aim to be clear span across the active channels of wetlands, and aim to maintain wetting of the full wetland front downslope of the crossing through the incorporation of as many culvert structures as required to achieve this. Use of a single pipe culvert for crossings over hillslope seepage wetlands should be avoided.

Capacity of crossing structures should be such that no impounding of flows upslope of the crossing occurs under normal flow events.

Decommissioning & Closure:

The decommissioning and removal of infrastructure during closure will result in disturbances similar to the construction phase, and include:

- Mobilisation of pollutants;
- Disturbance of wetland habitat and fauna; and
- Increased sediment movement into wetlands.

7.4.6 Mobilisation of pollutants

Where activities have resulted in contamination of the underlying soils due to leaks or spills, decommissioning activities and the associated earthworks could result in mobilisation of the pollutants of if the contaminated sediments are disturbed. Pollutants could then enter downslope wetlands via surface runoff.

Mitigation

All solid waste and potentially polluting material should be removed from site during the decommissioning and closure activities. Any contaminated wetland soils encountered during decommissioning and closure activities will either need to be rehabilitated *in situ* under supervision of a qualified soil/wetland scientist or, if *in situ* rehabilitation is not possible, be removed from site and disposed of in a suitable waste disposal facility

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7.4.7 Disturbance of wetland habitat and fauna

Similar as during the construction phase, disturbance to wetland habitat and fauna is likely to materialise from decommissioning related activities such as temporary stockpiles, turning circles for vehicles and machinery, constructor's camps etc. extending into the wetland area, as well as increased human traffic in the area. Illegal hunting and fishing activities are also likely to increase due to an influx of temporary labour to the area during the decommissioning phase.

Mitigation

Decommissioning activities should be restricted to the disturbed footprint, and no activities should take place within any of the wetlands. Where decommissioning activities need to extend beyond the disturbed footprint, the required servitude needs to be clearly demarcated in the field.

All wetland areas disturbed during decommissioning activities should be rehabilitated immediately following completion of decommissioning activities within the affected area. Rehabilitation should be done as per the guidelines in Section 8 of this report, and should include the ripping, scarifying, landscaping and revegetation of all disturbed areas.

7.4.8 Increased sediment movement into wetlands

Clearing of infrastructure and earthworks associated with site rehabilitation will likely expose large expanses of bare soil to erosion by wind and water. Vehicle tracks are likely to create preferential flow paths along which runoff water concentrates, leading to gully erosion on site and extensive sediment deposition in the downslope wetlands. Areas of sediment deposition within the wetland are likely to become colonised by pioneer species as well as alien vegetation. Depending on the degree of saturation of the deposited sediments, species such as *Typha capensis* (permanent to near permanently saturated areas) are likely to dominate. In more temporary areas, deposited sediments are likely to be colonised by weeds such as *Conyza*, *Tagetes*, *Verbena* etc.

Mitigation

Decommissioning activities should be restricted to the disturbed footprint, and no activities should take place within any of the wetlands. Where decommissioning activities need to extend beyond the disturbed footprint, the required servitude needs to be clearly demarcated in the field.

All disturbed areas should be rehabilitated immediately following completion of decommissioning activities within the affected area. Rehabilitation should be done as per the guidelines in Section 8 of this report, and should include the ripping, scarifying, landscaping and revegetation of all disturbed areas.

Cumulative:

The proposed and existing mining activities will contribute to overall wetland degradation of the area and increase stress on the wetland systems. Wetlands were classed as the most threatened ecosystem type within South Africa (National Biodiversity Assessment 2011: Freshwater Component (Nel *et al*., 2011b)), and all of the wetland ecosystem types that occur and would have

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occurred on site under natural conditions are considered Critically Endangered or Endangered. This makes clear the level of disturbance that the wetlands of the area have undergone, and the extent of wetland habitat that has already been lost. The proposed mining and associated activities will contribute towards further wetland degradation an increase stress within wetland ecosystems, likely resulting in the wetlands entering a trajectory of change towards a lower PES score.

7.5 Other linear infrastructure

The following impacts are expected due to linear infrastructure on site (see Figure 17 above):

Pre-construction & Construction:

- Loss and disturbance of wetland habitat;
- Increased erosion and sedimentation;
- Piping and preferential flow paths;
- Altered water movement through the landscape; and
- Water quality deterioration.

7.5.1 Loss and disturbance of wetland habitat

Where the pipeline crosses wetlands, wetland vegetation will be disturbed during the construction process. Disturbance is also likely to extend further into the wetland due to movement of construction workforce and machinery. Disturbed areas will be more prone to erosion and invasion by alien vegetation.

Where the powerlines cross wetlands, and specifically where poles need to be erected within the delineated wetlands, construction activities will result in disturbances to the wetland habitat through trampling of the vegetation, compaction of soils and also disturbance of soils where excavations are required. Given that the vegetation of the area is short to medium high grassland, no vegetation clearing will be required, though the vegetation is likely to get trampled. Disturbed areas will be more susceptible to erosion and will provide opportunity for alien invasive species to establish.

Mitigation

This impact cannot be avoided; however, it can be limited in extent and magnitude. The construction servitude needs to be kept to a minimum to limit vegetation destruction, and needs to be clearly demarcated in the field. No activities should be allowed outside the construction servitude. Access routes should be limited to the service road that will likely be constructed along the pipeline, or to a single construction access road. All materials stockpiles and construction camps should be located outside wetland areas. It should not be necessary to re-plant any areas, but rather allow natural re-vegetation to occur. The areas where vegetation is destroyed and disturbed will however need to be monitored against invasion by alien vegetation and, if encountered, will need to be removed. If natural re-vegetation is unsuccessful, seeding and planting of the area will need to be implemented in consultation with an appropriate wetland vegetation specialist.

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7.5.2 Increased erosion and sedimentation

Clearing of vegetation along the pipeline and powerline servitude and disturbance to the soil through excavations will increase the risk of erosion and sediment transport into wetlands. Where sediments deposit in wetlands, changes to the wetland vegetation are expected.

Mitigation

- Undertake construction activities in the dry season;
- Limit the extent of the construction servitude to as small an area as possible;
- Excavated soils should be stockpiled on the upslope side of the excavated trench so that eroded sediments off the stockpile are washed back into the trench;
- Concentration and accumulation of flows along the servitude should be prevented by regularly providing for surface runoff to flow into the adjacent grassland rather than along the construction servitude and into the wetlands;and
- Closure and rehabilitation of the pipeline servitude should commence as soon as the pipeline has been laid in the trench.

7.5.3 Piping and preferential flow paths

A coarse bedding material will likely be utilised around the pipe within the trench. This bedding material is likely to be more permeable than the natural soils of the area and could create a preferential flow path in the subsurface which, over time, could result in erosion on the surface and even pipe failure in extreme cases.

Mitigation

It is recommended that trench breakers be installed along the pipeline trench. A material with low hydrological conductivity (a Bentonite mix is recommended), in the form of trench breakers should be packed around the pipe and should be installed at regular intervals to prevent the pipeline behaving as a conduit and to intercept any concentrated flow down the pipeline route. Spacing between trench breakers should vary depending on the slope of the landscape – the steeper the slope the smaller the distance between trench breakers. Spacing should be such that flows backing up behind one trench breaker extend back to the base of the previous trench breaker.

7.5.4 Altered water movement through the landscape

Excavation of the trench could alter water movement through the landscape where the excavation leads to the destruction of control features within the subsurface, e.g. sub-surface rock banks. Excavations that extend into such features could in effect “breach subsurface dams” and create preferential flow paths that could lead to erosion.

Mitigation

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Where subsurface control features such as rock banks or ledges are damaged by the trench excavations, these control features should be re-created within the trench to prevent the formation of preferential flow paths.

7.5.5 Water quality deterioration

Use of polluting substances during construction (e.g. oil, diesel and cement) could lead to deterioration of water quality if washed into adjacent wetlands.

Mitigation

- Institute environmental best practice guidelines as per the DWA Integrated Environmental Management Series for Construction Activities;
- Limit quantities of hazardous substances on site to the volumes used during 1 days work;
- Dispose of all soil contaminated due to leaks or spills as hazardous waste; and
- Waste should be stored on site in clearly marked containers in a demarca.ted area. All waste must be disposed of offsite.

Operation:

- Increased flows and erosion due to leaks or pipe failure
- Disturbance to wetland habitat due to maintenance activities

7.5.6 Water quality deterioration due to leaks or pipe failure

Leaks or failure of the pipe could result in water quality deterioration of affected wetlands as dirty water is discharged directly into these systems.

Mitigation

Leak detection measures should be installed along the pipeline so that pipe failure, should it occur, will be noticed immediately and water flow through the pipe can be stopped. Twice monthly checks along the route should be undertaken to scan for signs of leaks.

7.5.7 Disturbance to wetland habitat due to maintenance activities

Maintenance activities such as vegetation clearing and burning along the powerline or pipeline servitudes could lead to disturbances to wetland vegetation and fauna.

Mitigation

No burning of vegetation within the wetlands should take place unless it forms part of the burning regime established in a fire management plan for the Leeuwpan Coal Mine compiled by a suitably qualified expert.

Maintenance access to the servitudes should be via a single access track, with no vehicular movement through the wetlands along the servitudes other than along the maintenance track.

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Decommissioning & Closure:

The decommissioning and removal of infrastructure during closure will result in disturbances similar to the construction phase, and include:

- Mobilisation of pollutants;
- Disturbance of wetland habitat and fauna; and
- Increased sediment movement into wetlands.

7.5.8 Mobilisation of pollutants

Where activities have resulted in contamination of the underlying soils due to leaks or spills, decommissioning activities and the associated earthworks could result in mobilisation of the pollutants of if the contaminated sediments are disturbed. Pollutants could then enter downslope wetlands via surface runoff.

Mitigation

All solid waste and potentially polluting material should be removed from site during the decommissioning and closure activities. Any contaminated wetland soils encountered during decommissioning and closure activities will either need to be rehabilitated *in situ* under supervision of a qualified soil/wetland scientist or, if *in situ* rehabilitation is not possible, be removed from site and disposed of in a suitable waste disposal facility

7.5.9 Disturbance of wetland habitat and fauna

Similar as during the construction phase, disturbance to wetland habitat and fauna is likely to materialise from decommissioning related activities such as temporary stockpiles, turning circles for vehicles and machinery, constructor's camps etc. extending into the wetland area, as well as increased human traffic in the area. Illegal hunting and fishing activities are also likely to increase due to an influx of temporary labour to the area during the decommissioning phase.

Mitigation

Decommissioning activities should be restricted to the disturbed footprint, and no activities should take place within any of the wetlands. Where decommissioning activities need to extend beyond the disturbed footprint, the required servitude needs to be clearly demarcated in the field.

All disturbed areas should be rehabilitated immediately following completion of decommissioning activities within the affected area. Rehabilitation should be done as per the guidelines in Section 8 of this report, and should include the ripping, scarifying, landscaping and revegetation of all disturbed areas.

7.5.10 Increased sediment movement into wetlands

Clearing of infrastructure and earthworks associated with site rehabilitation will likely expose large expanses of bare soil to erosion by wind and water. Vehicle tracks are likely to create preferential

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flow paths along which runoff water concentrates, leading to gully erosion on site and extensive sediment deposition in the downslope wetlands. Areas of sediment deposition within the wetland are likely to become colonised by pioneer species as well as alien vegetation. Depending on the degree of saturation of the deposited sediments, species such as *Typha capensis* (permanent to near permanently saturated areas) are likely to dominate. In more temporary areas, deposited sediments are likely to be colonised by weeds such as *Conyza*, *Tagetes*, *Verbena* etc.

Mitigation

Decommissioning activities should be restricted to the disturbed footprint, and no activities should take place within any of the wetlands. Where decommissioning activities need to extend beyond the disturbed footprint, the required servitude needs to be clearly demarcated in the field.

All disturbed areas should be rehabilitated immediately following completion of decommissioning activities within the affected area. Rehabilitation should be done as per the guidelines in Section 8 of this report, and should include the ripping, scarifying, landscaping and revegetation of all disturbed areas, except within wetland areas.

Cumulative:

The proposed and existing mining activities will contribute to overall wetland degradation of the area and increase stress on the wetland systems. Wetlands were classed as the most threatened ecosystem type within South Africa (National Biodiversity Assessment 2011: Freshwater Component (Nel *et al*., 2011b)), and all of the wetland ecosystem types that occur and would have occurred on site under natural conditions are considered Critically Endangered or Endangered. This makes clear the level of disturbance that the wetlands of the area have undergone, and the extent of wetland habitat that has already been lost. The proposed mining and associated activities will contribute towards further wetland degradation an increase stress within wetland ecosystems, likely resulting in the wetlands entering a trajectory of change towards a lower PES score.

7.6 Surface infrastructure

The following impacts are expected due to the surface infrastructure on site (see Figure 18 below):

Pre-construction & Construction:

The following impacts are expected during the construction phase:

- Loss and disturbance of wetland habitat;
- Increased sediment movement into wetlands;
- Increase in alien and pioneer vegetation; and
- Water quality deterioration.

7.6.1 Loss of wetland habitat

The location of the new proposed surface infrastructure is illustrated in the figure below. From the image it is clear that the infrastructure will mostly be located within a footprint already heavily disturbed by mining, though right on the edge of a remnant piece of hillslope seepage wetland.

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In addition to the direct wetland loss, disturbance to the wetland habitat adjacent to the direct development footprint will also results in habitat deterioration and the potential loss and displacement of species. Disturbance will also increase the opportunity for alien vegetation and weeds to establish and displace indigenous species. The wetlands likely to be affected by such disturbance are however already heavily disturbed through past cultivation and adjacent mining activities.

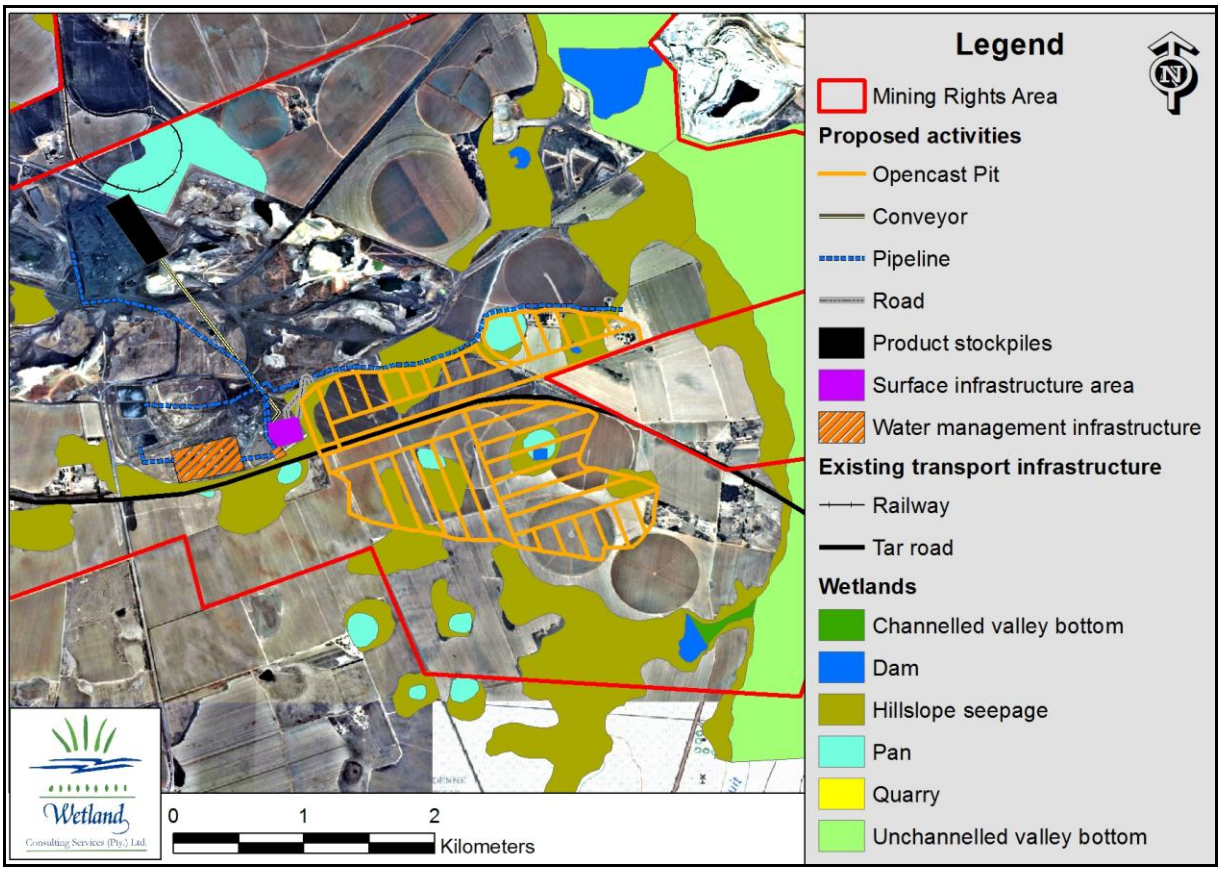


Figure 18: Proposed new surface infrastructure in relation to delineated wetlands

Mitigation

The proposed development footprint and construction servitudes, including laydown areas etc., should be clearly demarcated in the field and no construction activities should take place outside the demarcated areas. Ideally all wetland systems should be fenced off using standard 5 strand cattle fences to prevent vehicular access to these areas.

No water for construction purposes should be abstracted from any of the wetlands on site unless authorized by the DWA b y means of an approved WUL.

Rehabilitation of disturbed wetland habitat shall commence immediately after construction by re-establishing vegetation (see Section 8). All disturbed areas shall be re-vegetated in consultation with an indigenous plant expert, and only indigenous sedges, shrubs, and grasses shall be used to restore biodiversity.

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7.6.2 Increased sediment movement into wetlands

Site clearance and preparation activities, including excavations and soil movement, will expose large areas of bare soil to erosion by wind and water. Clearing vegetation and compacting soils will increase the generation of surface runoff volumes and velocities. As a consequence, a significant increase in the movement of sediment off the construction sites and into the adjacent wetlands is expected.

Increased sediment inputs to the wetlands will increase turbidity, alter the benthic habitats and likely lead to changes in vegetation structure and composition as deposited sediments are colonised by species such as *Typha capensis* or *Imperata cylindrica,* depending on the duration of saturation.

Mitigation

The proposed development footprints must be kept as small as possible. Construction activities should be undertaken during the dry season. Construction activities within the development footprint should also be phased to minimise the extent of bare soils at any one time, with vegetation clearing activities delayed to the absolute last moment possible within the construction schedule. Clearing of vegetation and the subsequent stalling of construction activities so as to leave areas of bare soil unprotected for extended periods must be avoided.

Stormwater management measures must be implemented during the construction phase to limit concentration of flows and the generation of high velocity flows that will exacerbate erosion risk. Regular low level humps should be installed along linear preferential flow paths such as construction roads/tracks that run perpendicular to the slope to slow down and disperse flows.

Sediment barriers as per the guidelines provided below (Section 8 – Rehabilitation) should be installed at the start of construction activities.

7.6.3 Increase in alien and pioneer vegetation

Disturbance resulting from construction activities will provide opportunity for alien species and pioneer vegetation to establish and colonise wetland habitat. Alien vegetation can displace indigenous species and alter habitat quality, decreasing biodiversity. Alien vegetation and pioneer species can also increase the susceptibility of the wetland to erosion and significant fire damage.

Mitigation

The area of disturbance should be minimised and the construction servitude clearly demarcated, with no activities outside the demarcated area.

An alien vegetation management plan should be compiled and implemented for the entire impacted area and immediate vicinity prior to the onset of construction activities. Identified areas of alien vegetation should be managed and ideally removed in consultation with an ecologist to ensure that alien species that might provide habitat/nesting sites for important species are not removed.

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All rehabilitated sites should be surveyed for alien species on a yearly basis until a stable vegetation assemblage and cover has been obtained. Such surveys should be done by a suitably qualified specialist familiar with succession on rehabilitated areas.

7.6.4 Water quality deterioration

During the construction phase, as activities are taking place within and adjacent to wetlands, there is a possibility that water quality can be impaired, particularly during the construction phase. Typically impairment will occur as a consequence of sediment disturbance resulting in an increase in turbidity. Water quality may also be impaired as a consequence of accidental spillages and the intentional washing and rinsing of equipment. It is likely that hydrocarbons will be stored and used on site, as well as cement and other potential pollutants.

Mitigation

Ensure that no equipment is washed in the streams and wetlands of the area, and if washing facilities are provided, that these are placed no closer than 100m from a wetland or water course.

In order to reduce the potential impacts associated with the introduction of contaminants dissolved or suspended in the runoff from construction sites, where practically possible, no runoff should be introduced into wetlands directly. Introduction into dryland areas is preferred as the vegetation and soils provide an opportunity to limit the movement of contaminants and the environment is conducive for natural degradation.

Potential contaminants used and stored on site should be stored and prepared on bunded surfaces to contain spills and leaks. Sufficient spill clean-up material must be kept on site at all times to deal with minor spills. Larger spills should be reported to the ECO and the relevant authorities (DWA) immediately, with specialists appointed to oversee the clean-up operations.

Operation:
The following impacts are expected:

- Increased surface runoff and erosion;
- Erosion and increased sedimentation; and
- Deterioration in water quality.

7.6.5 Increased surface runoff and erosion

The increase in hardened surfaces that will result from the construction of the surface infrastructure will increase surface run-off volumes from the site. Clean stormwater will be discharged into adjacent wetlands, increasing flow and saturation within the wetlands.

Increased flows in the wetland could result in increased erosion risk and channel incision within the wetland, though the low slope and isolated nature of the wetlands surrounding the surface infrastructure area are unlikely to represent a major erosion risk. Increased water inputs to these

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wetlands are however likely to alter vegetation composition, with species adapted to permanent saturation such as *Typha capensis* and *Phragmites australis* are likely to increase.

Mitigation

- Minimise extent of hardened surfaces;
- Implement a detailed stormwater management plan which aims to retain the pre-development run-off characteristics of the site for regular return storm events;
- Convey stormwater in grassed swales rather than lined canals/trenches as far as possible to maximise infiltration and minimise erosion;
- Stormwater discharge points should be protected against erosion and incorporate energy dissipaters. Flows should be encouraged to disperse across a wide an area of the wetland as possible;
- Stormwater should be discharged into adjacent grassland and not directly into the delineated wetlands as far as possible;
- Fixed point photography should be undertaken of the discharge points to monitor for erosion damage. Photographs should be taken pre-development to provide a baseline, and then in December and March during the rainy season. If erosion is observed, corrective measures should be implemented via the appointment of a wetland rehabilitation specialist.

7.6.6 Deterioration in water quality

Discharge of stormwater into adjacent wetlands will likely lead to deteriorating water quality with deleterious impacts to aquatic biodiversity. The storage of fuel on site, the wash bay and workshops provide sources of hydrocarbon pollution, while stormwater is also likely to convey pollutants to the wetlands.

Mitigation

A detailed surface water management plan should be drawn up for the main shaft area that complies fully with GN704 in terms of the separation of clean and dirty stormwater. Dirty stormwater should be captured in a pollution control dam on site and no discharge of dirty stormwater should be allowed into the wetlands on site. The dirty water management system should have a minimum capacity to cope with a 1:50 year storm event without overflow. Dirty water should be re-used as far as possible within the mining operations.

Decommissioning & Closure:

The decommissioning and removal of infrastructure during closure will result in disturbances similar to the construction phase, and include:

- Mobilisation of pollutants;
- Disturbance of wetland habitat and fauna; and
- Increased sediment movement into wetlands.

7.6.7 Mobilisation of pollutants

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Where activities have resulted in contamination of the underlying soils due to leaks or spills, decommissioning activities and the associated earthworks could result in mobilisation of the pollutants if the contaminated sediments are disturbed. Pollutants could then enter downslope wetlands via surface runoff.

Mitigation

All solid waste and potentially polluting material should be removed from site during the decommissioning and closure activities. Any contaminated wetland soils encountered during decommissioning and closure activities will either need to be rehabilitated *in situ* under supervision of a qualified soil/wetland scientist or, if *in situ* rehabilitation is not possible, be removed from site and disposed of in a suitable waste disposal facility

7.6.8 Disturbance of wetland habitat and fauna

Similar as during the construction phase, disturbance to wetland habitat and fauna is likely to materialise from decommissioning related activities such as temporary stockpiles, turning circles for vehicles and machinery, constructor's camps etc. extending into the wetland area, as well as increased human traffic in the area. Illegal hunting and fishing activities are also likely to increase due to an influx of temporary labour to the area during the decommissioning phase.

Mitigation

Decommissioning activities should be restricted to the disturbed footprint, and no activities should take place within any of the wetlands. Where decommissioning activities need to extend beyond the disturbed footprint, the required servitude needs to be clearly demarcated in the field.

All disturbed areas should be rehabilitated immediately following completion of decommissioning activities within the affected area. Rehabilitation should be done as per the guidelines in Section 8 of this report, and should include the ripping, scarifying, landscaping and revegetation of all disturbed areas.

7.6.9 Increased sediment movement into wetlands

Clearing of infrastructure and earthworks associated with site rehabilitation will likely expose large expanses of bare soil to erosion by wind and water. Vehicle tracks are likely to create preferential flow paths along which runoff water concentrates, leading to gully erosion on site and extensive sediment deposition in the downslope wetlands. Areas of sediment deposition within the wetland are likely to become colonised by pioneer species as well as alien vegetation. Depending on the degree of saturation of the deposited sediments, species such as *Typha capensis* (permanent to near permanently saturated areas) are likely to dominate. In more temporary areas, deposited sediments are likely to be colonised by weeds such as *Conyza*, *Tagetes*, *Verbena* etc.

Mitigation

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Decommissioning activities should be restricted to the disturbed footprint, and no activities should take place within any of the wetlands. Where decommissioning activities need to extend beyond the disturbed footprint, the required servitude needs to be clearly demarcated in the field.

All disturbed areas should be rehabilitated immediately following completion of decommissioning activities within the affected area. Rehabilitation should be done as per the guidelines in Section 8 of this report, and should include the ripping, scarifying, landscaping and revegetation of all disturbed areas.

Cumulative:

The proposed and existing mining activities will contribute to overall wetland degradation of the area and increase stress on the wetland systems. Wetlands were classed as the most threatened ecosystem type within South Africa (National Biodiversity Assessment 2011: Freshwater Component (Nel *et al*., 2011b)), and all of the wetland ecosystem types that occur and would have occurred on site under natural conditions are considered Critically Endangered or Endangered. This makes clear the level of disturbance that the wetlands of the area have undergone, and the extent of wetland habitat that has already been lost. The proposed mining and associated activities will contribute towards further wetland degradation an increase stress within wetland ecosystems, likely resulting in the wetlands entering a trajectory of change towards a lower PES score.

7.7 Water management infrastructure

The following impacts are expected due to the water management infrastructure on site:

Pre-construction & Construction:
The following impacts are expected during the construction phase:

- Loss and disturbance of wetland habitat;
- Increased sediment movement into wetlands;
- Increase in alien and pioneer vegetation; and
- Water quality deterioration.

7.7.1 Loss of wetland habitat

The location of the new proposed water management infrastructure is illustrated in the figure below. From the image it is clear that the infrastructure will mostly be located within a footprint already heavily disturbed by mining, though right on the edge of a remnant piece of hillslope seepage wetland. A total of approximately 0.25 hectares of wetland habitat will be permanently destroyed during footprint clearance and construction activities on site.

In addition to the direct wetland loss, disturbance to the wetland habitat adjacent to the direct development footprint will also results in habitat deterioration and the potential loss and displacement of species. Disturbance will also increase the opportunity for alien vegetation and weeds to establish and displace indigenous species. The wetlands likely to affected by such disturbance are however already heavily disturbed through past cultivation and adjacent mining activities.

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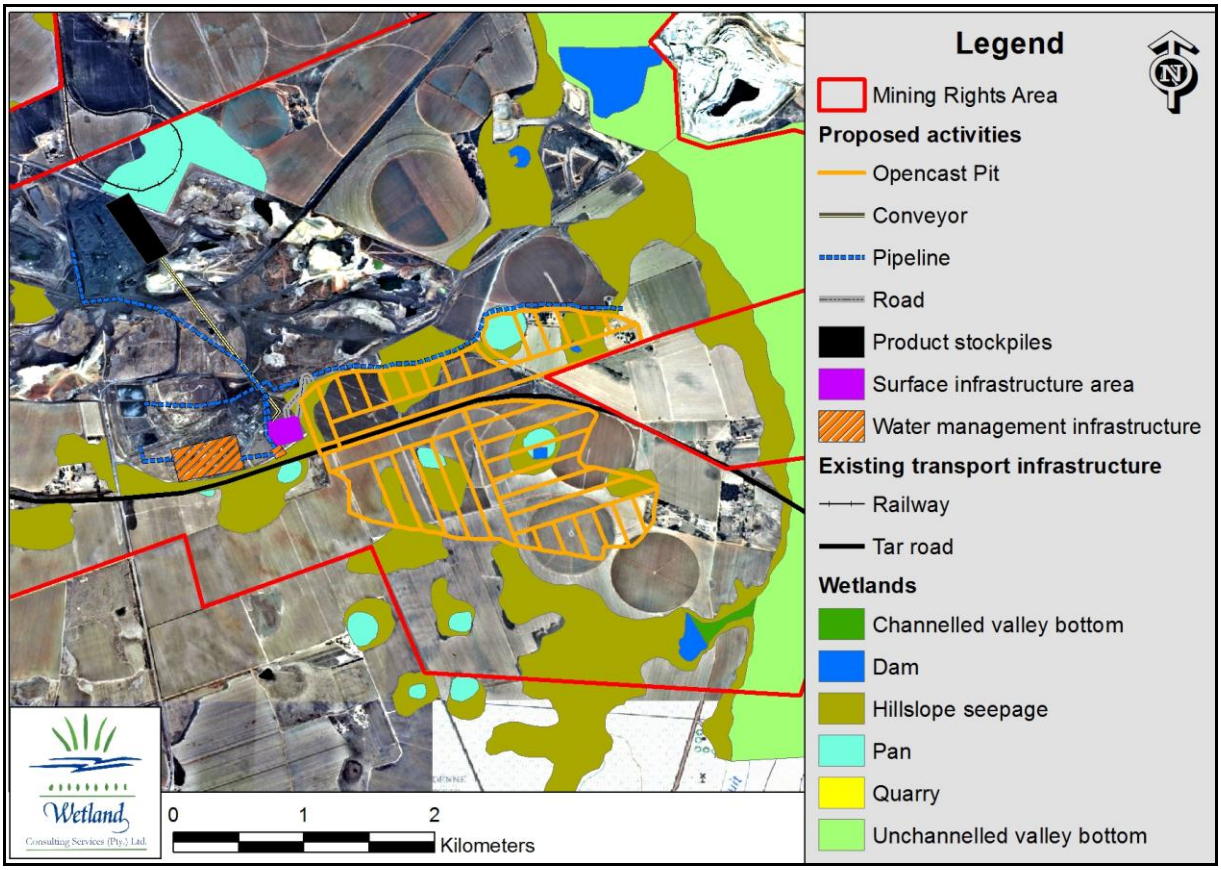


Figure 19: Proposed new water management infrastructure in relation to delineated wetlands

Mitigation

The proposed location of the water management infrastructure should be shifted to ensure that all new proposed PCD's and dirty water dams are located in previously disturbed areas outside delineated wetlands.

The proposed development footprint and construction servitudes, including laydown areas etc., should be clearly demarcated in the field and no construction activities should take place outside the demarcated areas. Ideally all wetland systems should be fenced off using standard 5 strand cattle fences to prevent vehicular access to these areas.

No water for construction purposes should be abstracted from any of the wetlands on site unless authorized by the DWA.

Rehabilitation of disturbed wetland habitat shall commence immediately after construction by re-establishing vegetation (see Section 8). All disturbed areas shall be re-vegetated in consultation with an indigenous plant expert, and only indigenous sedges, shrubs, and grasses shall be used to restore biodiversity.

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7.7.2 Increased sediment movement into wetlands

Site clearance and preparation activities, including excavations and soil movement, will expose large areas of bare soil to erosion by wind and water. Clearing vegetation and compacting soils will increase the generation of surface runoff volumes and velocities. As a consequence, a significant increase in the movement of sediment off the construction sites and into the adjacent wetlands is expected.

Increased sediment inputs to the wetlands will increase turbidity, alter the benthic habitats and likely lead to changes in vegetation structure and composition as deposited sediments are colonised by species such as *Typha capensis* or *Imperata cylindrica,* depending on the duration of saturation.

Mitigation

The proposed development footprints must be kept as small as possible. Construction activities should be undertaken during the dry season. Construction activities within the development footprint should also be phased to minimise the extent of bare soils at any one time, with vegetation clearing activities delayed to the absolute last moment possible within the construction schedule. Clearing of vegetation and the subsequent stalling of construction activities so as to leave areas of bare soil unprotected for extended periods must be avoided.

Stormwater management measures must be implemented during the construction phase to limit concentration of flows and the generation of high velocity flows that will exacerbate erosion risk. Regular low level humps should be installed along linear preferential flow paths such as construction roads/tracks that run perpendicular to the slope to slow down and disperse flows.

Sediment barriers as per the guidelines provided below (Section 8 – Rehabilitation) should be installed at the start of construction activities.

7.7.3 Increase in alien and pioneer vegetation

Disturbance resulting from construction activities will provide opportunity for alien species and pioneer vegetation to establish and colonise wetland habitat. Alien vegetation can displace indigenous species and alter habitat quality, decreasing biodiversity. Alien vegetation and pioneer species can also increase the susceptibility of the wetland to erosion and significant fire damage.

Mitigation

The area of disturbance should be minimised and the construction servitude clearly demarcated, with no activities outside the demarcated area.

An alien vegetation management plan should be compiled and implemented for the entire impacted area and immediate vicinity prior to the onset of construction activities. Identified areas of alien vegetation should be managed and ideally removed in consultation with an ecologist to ensure that alien species that might provide habitat/nesting sites for important species are not removed.

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All rehabilitated sites should be surveyed for alien species on an annual basis until a stable vegetation assemblage and cover has been obtained. Such surveys should be done by a suitably qualified specialist familiar with succession on rehabilitated areas.

7.7.4 Water quality deterioration

During the construction phase, as activities are taking place within and adjacent to wetlands, there is a possibility that water quality can be impaired, particularly during the construction phase. Typically impairment will occur as a consequence of sediment disturbance resulting in an increase in turbidity. Water quality may also be impaired as a consequence of accidental spillages and the intentional washing and rinsing of equipment. It is likely that hydrocarbons will be stored and used on site, as well as cement and other potential pollutants.

Mitigation

Ensure that no equipment is washed in the streams and wetlands of the area, and if washing facilities are provided, that these are placed no closer than 100m from a wetland or water course.

In order to reduce the potential impacts associated with the introduction of contaminants dissolved or suspended in the runoff from construction sites, where practically possible, no runoff should be introduced into wetlands directly. Introduction into dryland areas is preferred as the vegetation and soils provide an opportunity to limit the movement of contaminants and the environment is conducive for natural degradation.

Potential contaminants used and stored on site should be stored and prepared on bunded surfaces to contain spills and leaks. Sufficient spill clean-up material must be kept on site at all times to deal with minor spills. Larger spills should be reported to the ECO and the relevant authorities (DWA) immediately, with specialists appointed to oversee the clean-up operations.

Operation:
The following impacts to the wetlands are expected during the operational phase:

- Water quality deterioration due to seepage of polluted water out of the dam;
- Water quality deterioration due to regular overflow of the dams; and
- Erosion due to concentrated overflow from the dams.

7.7.5 Water quality deterioration - Seepage out of the dams

Seepage or leakage of polluted water out of dirty water storage dams and pollution control dams could result in water quality deterioration within adjacent and downslope wetlands.

Mitigation

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All dirty water dams should be lined. Regular inspections and maintenance of the liner should be undertaken to ensure no seepage of polluted water out of the dams. If damaged, the liner should be repaired or replaced as soon as possible.

The existing water quality monitoring plan should be expanded to include all water management infrastructures on the Leeuwpan Coal Mine (existing and proposed). Sampling sites should be located so that any contamination of water resources from the water management infrastructure can be rapidly identified and located.

Emergency response procedures for failure of any water infrastructure on the mine should be established and regularly tested. All staff should be aware of the procedures and how to alert management of any failures.

7.7.6 Water quality deterioration – Overflow of dams

Regular overflow of dirty water management infrastructure into adjacent and downslope wetlands could result in water quality deterioration. The capacity of the water management infrastructure is not known, but is assumed to comply with GN704. Incorrect management of the dams, e.g. maintaining water levels too high within the dams, could result in regular overflowing of the dams into adjacent and downslope wetlands. Silting up of the dams will also over time decrease the capacity of the dams and increase the likelihood and frequency of overflow.

Mitigation

It should be ensured that the storage capacity of all dams is sufficient and compliant with legislation and best practice guidelines.

Water levels in the dams should at all times be carefully managed so as to ensure sufficient storage capacity. Daily inspections of water levels should be undertaken during the summer months (October to April) and a log book kept.

Every overflow of dirty water dams should be recorded in a detailed log book, including reasons for overflow (e.g. amount of rainfall preceding overflow event).

Silt traps should be installed upstream of all pollution control dams and dirty water storage dams to limit silt deposition in the dams. Dams should be inspected for siltation and cleaned (if necessary) before the start of every summer rainfall season.

7.7.7 Erosion due to overflow of dams

Regular overflow of dirty water management infrastructure into adjacent and downslope wetlands will result in concentrated, channeled, surface flow entering the hillslope seepage wetlands, posing a high risk of erosion. Erosion will result in a localized lowering of the water table and result in desiccation of a portion of the wetland, as well as increased sedimentation within the wetland.

Mitigation

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See mitigation measures recommended above to minimise overflow events. In addition, any overflow spillways as well as their discharge points should be protected from erosion by ensuring establishment of dense vegetation cover within the spillway and at its discharge point.

The spillways and discharge points should be inspected for erosion damage at the end of every rainfall season and all erosion damage repaired. Should erosion pose a significant problem, protection of the spillway with harder measures (e.g. gabions, rock aprons etc.) should be considered, as well as the use of energy dissipaters.

Decommissioning & Closure:

Impacts expected during the decommissioning and closure phase include:

- Disturbance to wetland habitat and biota;
- Increased occurrence of alien and weedy species;
- Water quality deterioration; and
- Increased sediment movement into wetlands

7.7.8 Disturbance to wetland habitat and biota

Decommissioning and removal of the water management infrastructure, and rehabilitation of affected sites, could result in disturbance to adjacent wetland habitat through for example injudicious driving on site and incorrect waste disposal/dumping, as well as through increased noise levels and human traffic.

Mitigation

Decommissioning and closure activities should ideally be restricted to the disturbed footprint, and only existing roads and tracks on site should be utilised. Unless rehabilitation activities are required within wetlands areas, all wetland areas should be avoided during closure activities.

Any wetland area disturbed during closure activities should be rehabilitated. Soil compaction should be ameliorated through ripping and scarifying, followed by landscaping to the natural landscape profile. Contaminated soils and materials should be removed from site. Bare soil areas should be re-vegetated using a mix of indigenous grass species. Vegetation re-establishment should be regularly monitored to ensure sustainable cover is achieved and maintained.

7.7.9 Increased occurrence of alien and weedy species

Disturbances to wetland vegetation during closure activities could provide opportunity for invasion by alien species and weeds.

Mitigation

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Decommissioning and closure activities should ideally be restricted to the disturbed footprint and only existing roads and tracks on site should be utilised. Unless rehabilitation activities are required within wetlands areas, all wetland areas should be avoided during closure activities.

The alien vegetation management plan of the mine should be implemented for at least a further 5 years following completion of decommissioning activities, or until alien vegetation has been shown not to represent a threat. Identified areas of alien vegetation should be managed and ideally removed in consultation with an ecologist to ensure that alien species do not provide habitat/nesting sites for important species.

All rehabilitated areas should be surveyed for alien species on a 6 monthly basis until a stable vegetation assemblage and cover has been obtained. Such surveys should be done by a suitably qualified specialist familiar with succession on rehabilitated areas.

7.7.10 Water quality deterioration

During decommissioning and closure activities any contaminants found within the soils underlying the water management infrastructure could be mobilized and enter downslope wetlands, leading to water quality deterioration.

Mitigation

All contaminated soil and material should be removed from site if onsite amelioration and rehabilitation is not possible (consult relevant specialists). All removed material should be disposed of in suitable waste facilities fully compliant with the relevant legislation.

7.7.11 Increased sediment movement into wetlands

Site clearance and rehabilitation activities, including excavations and soil movement, will expose large areas of bare soil to erosion by wind and water. Clearing vegetation and compacting soils will increase the generation of surface runoff volumes and velocities. As a consequence, a significant increase in the movement of sediment off the rehabilitation site and into the adjacent wetlands is expected.

Increased sediment inputs to the wetlands will increase turbidity, alter the benthic habitats and likely lead to changes in vegetation structure and composition as deposited sediments are colonised by species such as *Typha capensis*.

Mitigation

The area of disturbance should be minimised and the area of activity during closure clearly demarcated, with no activities outside the demarcated area.

Bare soil areas should be revegetated as soon as possible.

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Sediment barriers should be installed downslope of large bare soil areas until vegetation cover has re-established.

Cumulative:
The water management infrastructure proposed for the Leeuwpan Coal Mine is designed as a mitigation measure to reduce the impact of the mine on water quality within adjacent water courses. However, such water management infrastructure is unlikely to be 100% effective in trapping pollutants, and some contamination of surrounding wetlands and water courses is expected. The water management infrastructure is thus likely to contribute to water quality deterioration within the Upper Olifants River Catchment, though in the absence of the water quality infrastructure, the impact of the mine would likely be of much greater significance.

The proposed and existing mining activities will contribute to overall wetland degradation of the area and increase stress on the wetland systems. Wetlands were classed as the most threatened ecosystem type within South Africa (National Biodiversity Assessment 2011: Freshwater Component (Nel *et al*., 2011b)), and all of the wetland ecosystem types that occur and would have occurred on site under natural conditions are considered Critically Endangered or Endangered. This makes clear the level of disturbance that the wetlands of the area have undergone, and the extent of wetland habitat that has already been lost. The proposed mining and associated activities will contribute towards further wetland degradation an increase stress within wetland ecosystems, likely resulting in the wetlands entering a trajectory of change towards a lower PES score.

8. REHABILITATION

Any of the wetlands impacted during the construction process (and again during the decommissioning and closure phase) on site should be rehabilitated according the a well defined wetland rehabilitation plan compiled by a registered wetland specialist. The following measures are proposed to serve as broad guidelines to prevent unnecessary damage to the wetlands adjacent to the proposed development area. All measures detailed below should be implemented in consultation with a wetland specialist to ensure site and activity specific recommendations can be implemented.

8.1 Fencing or demarcation of affected area

Prior to any activities in the wetland areas, limits of construction related activities must be clearly demarcated so as to avoid unnecessary direct impacts to the vegetation beyond the limits of construction.

8.2 Re-vegetation/ rehabilitation

Bare soil areas within the wetlands resulting from construction/decommissioning activities should be re-vegetated as soon as possible following the disturbance. Wetland specialist must assist during re-vegetation and must prescribed the suitable species for re-vegetation of disturbed wetland areas. Typical species that should be considered include a mix of pioneer and climax species such as the following:

- *Digitaria eriantha*

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- *Chloris gayana*
- *Eragrostis curvula*
- *Eragrostis tef*
- *Cynodon dactylon*
- *Setaria spp.*
- *Panicum maximum*
- *Melinis repens*

Suitable seed mixes are available from Sakata Seed (Biomosome Grassveld Reclamation Mixture) and Advanced-Seed (Indigi Mix).

Soil compaction should be alleviated through ploughing/ripping and scarifying, followed by landscaping to the natural/surrounding landscape profile. Where ploughing/ripping takes place on slopes leading towards wetland areas or water courses, sediment barriers (see below) should be installed along the lower edge of the ploughed area.

Once soil preparation is complete, seed beds should be prepared as per the guidelines supplied by the seed supplier, or as follows: Furrows should be made in the soil by hand using hoes. Furrows must be made horizontally in the soil (parallel to slope) and should be spaced 0.4 meters (maximum) apart and at least 10 cm deep. Work should commence from the top of the slope and be conducted downwards and any loose soil and rocks from the process should be removed to prevent siltation of the wetlands downwards. The beds should follow the contours of the land and not in any way allow water to collect or flow in high volumes, thus creating erosion gullies. Larger clumps of soil and stones should be removed to prevent impeded flow of water. On steep slopes and high erosion risk areas the use of hessian blankets is recommended to increase erosion protection.

Seeding should commence as soon as the hessian is in place and seed bed preparation has been completed. Either hand or hydro-seeding can be considered, depending on the area required to be planted. Both hand and hydro-seeding must be done by professionals only. If any fertilizers are recommended these should be applied to the side slopes only and not within the wetland. If hydro seeding is selected for the seeding process the hydro-seeders used must run for 10 minutes at least before the commencement of the seeding project. This is to ensure adequate mixing of the seed and water. Water extraction for the hydro-seeding from the wetlands and pans is not allowed unless authorization is received from the Department of Water Affairs. A good rehabilitation grass mix can be obtained from Advanced-seed or African grass seeds, but must contain indigenous grass species which are conspicuous in the Highveld grassland.

Once the initial rehabilitation has been completed the rehabilitated areas should be checked for erosion at the end of the first summer. If erosion is observed, appropriate action should be taken to limit its extent.

8.3 The eradication of invasive plant species

Alien plants are likely to colonise the areas disturbed during the construction/decommissioning process. Areas disturbed during the construction process should be checked on a 6 monthly basis and any undesirable plants encountered in the areas immediately upstream and downstream of the rehabilitated areas should be removed, ideally by hand so as to reduce the risk of herbicides being transferred further into the wetlands.

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The removal of Category 1, 2 and 3 Declared Weeds is compulsory in terms of the regulations formulated under "The Conservation of Agricultural Resources Act" (Act No. 43 of 1983).

Exotic plantations should be checked for breeding owls and breeding raptors. If there are any, then these trees should be left as is, if at all possible.

8.4 Guide to installing erosion and siltation preventing devices:

Sediment transport during the construction/decommissioning period is likely. Efforts must be made to limit sediment transport beyond the limits of actual construction. Consult with wetland specialist to assist during installation of the below erosion and siltation devices.

Various methods are available to achieve this, some of which are described below.

It is important to note that these structures must be inspected regularly and replaced if any are found to be worn out or damaged. If sediments accumulate erosion barriers must be regularly cleaned.

Bidim™ Walls

These are made up of Bidim™ and /or shade cloth held in place with poles every 1 meter (maximum) apart. The Bidim should be placed against the y-poles and an extra length of about 1 meter should lie on the bottom of the stream facing upstream to ensure no sediment can escape underneath the wall. The height of the Bidim walls should be 10cm above the water level. These walls must cover the whole breadth of the gully and should not allow any water through that has not passed through the Bidim wall. These sediment barriers must be inspected every week to ensure they are still functioning. If a build-up of sediment occurs then the sediment must be removed. If the barriers are washed away by a flood or damaged in any way the replacement should occur as soon as possible.



Figure 20: A siltation screen below a construction site to prevent the movement of sediment downstream (image from www.wikipedia.com)

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Fibre rolls:

These should be placed horizontal to the flow direction and should cover the whole length of the slope or preferential flow path. Firstly a trench about 20cm (about half the height of the fibre roll) should be made in the flow path fibre roll placed in the trench. The trench should then be filled around the roll and compacted- using hand tools. The roll should then be permanently attached to the gully using wooden stakes leaving no more than 50mm of the stake protruding from the top of the roll. If high flow volumes are expected a double stake should be placed on both sides of the roll. These two stakes should then be tied together using wire and pulled taught.



Figure 21: Photograph of fibre rolls from EPA erosion control website

Straw bales:

These should be placed in their length across areas where erosion gullies have formed. Excavation of soil should be done to a depth half that of the bales. The bales should then be placed in the trench and secured using stakes. If any of the bales being used disintegrates it should be replaced. Broken bales will break up even further once in free flowing water. Surrounding soil needs to be replaced and compacted using hand tools.

Stake specification:

The stakes should all preferably be made from treated wood. The standard length of the stakes should be 800mm long and 40mm wide to ensure a wide variety of applications. To ensure the stakes are properly used they should all be installed a minimum of 500mm below the surface. Any protrusions above any structures should not exceed 50mm.

Hessian or fibre netting:

Netting should be used that allows 60% of the surface to be open to allow for the germination of seeds through the netting. These nets come in widths of 1.3 and 1.5 meters. These should be anchored to the bank walls with wooden stakes 1.5-2 meters apart. The hessian should also be applied vertically. The hessian should not be placed as far as the bottom or aquatic zone but should still reach the fibre rolls. Before the installation of the hessian, proper soil preparation by hand using a hoe must be done to ensure the proper seed beds are formed.

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9. MONITORING & EVALUATION

A number of aspects relating to the wetlands on site should be monitored to ensure effectiveness of mitigation and management measures, and to inform improvements where required.

9.1 Vegetation re-establishment

Areas re-vegetated following construction activities, decommissioning activities or any activities leading to vegetation removal and disturbance should be monitored following seeding to ensure successful establishment of vegetation. The following broad guidelines should apply, though the site specific details should be determined by a suitably qualified expert:

Vegetation monitoring in re-vegetated sites:

- Monthly monitoring for the first 6 months, then annual monitoring during the growing season;
- Monitoring for the first 6 months should focus on cover;
- 70% cover should be achieved after 3 months; and
- Annual monitoring (representative sample of re-vegetated sites only) should be undertaken until the appointed independent specialist is satisfied that a sustainable vegetation cover has been established.

9.2 Erosion

All wetland areas requiring revegetation should be monitored for signs of erosion. In addition, all of the following areas should also be monitored:

- All stormwater discharge points;
- All clean water diversion discharge points;
- All road and conveyor crossings; and
- All river diversions.

Monitoring activities should consist of **fixed point photography** as well as a w**alk through survey to observe for signs of erosion i**n the field. Monitoring should be done annually at the end of the rainy season. Any erosion damage observed should be repaired immediately.

9.3 Surface water quality monitoring program

The proposed new activities should be included within the Leeuwpan Coal Mine surface water quality and biomonitoring monitoring plan. As a minimum the points as indicated in Figure 21 below should be included in the plan, ***though if existing monitoring points occupy a similar location and are considered suitable, the existing monitoring points should be retained***. The following should be monitored (as far as possible):

- Water quality (pH, EC, TDS, SO4 as well as standard anions and cations) – monthly;
- Aquatic macro-invertebrates (SASS) – biannually (start and end of wet season); and

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- Diatoms – bi-annually (start and end of wet season)

It is recommended that monitoring at these points commences as soon as possible and at the latest at the onset of construction activities. Commencing monitoring immediately will allow for the baseline conditions to be accurately established prior to any impacts materializing.



Figure 22: Additional points (shown as yellow circles) to include within the surface water quality monitoring programme for the mine

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10. CONCLUSION

In total ***the area classified as wetland covers 1 382 hectares, which makes up roughly 32.5 % of the study area***. Approximately 820 hectares of the site has however already been disturbed by historic and current surface mining activities, suggesting that the wetland extent on site was likely significantly more prior to the onset of mining activities.

The wetlands on site exist within a landscape currently dominated by agricultural (cultivation, grazing) and mining activities, and these land uses have had an influence on the current extent and condition of the majority of the wetlands within the study area. Many of the wetlands and their catchments are currently, or have historically been, cultivated, or lie in close proximity to active mining activities, disturbances that have had an influence on the vegetation composition, geomorphology and hydrology of the wetlands. No pristine wetlands were found to occur within the study area, and the majority of the wetlands were found to be Moderately Modified (C). Almost 19 % of wetlands were classified as seriously modified (E), consisting mostly of hillslope seepage wetlands cultivated in their entirety, as well as a number of heavily impacted pans.

The two large valley bottom wetland systems on site, the Bronkhorstspruit and its tributary in the west of the study area, are considered to be of **High (B)** ecological importance and sensitivity, mostly due to the role they play in biodiversity support and as ecological corridors. The remainder of the wetlands are either of Moderate (C) or Low (D) ecological importance, related mostly to the level of disturbance these systems have undergone.

The existing mining activities on site, as well as the proposed new opencast pit and associated surface infrastructure will have a number of impacts on the wetlands on site. Many of the impacts associated with the supporting infrastructure required for mining can be successfully mitigated to reduce the impact to wetlands. The impacts of opencast mining, specifically the loss of wetland habitat and the permanent alteration of the hydrological characteristics of the landscape within the opencast footprints, are more difficult to address.

The significance of the loss of the wetlands within the proposed opencast footprints is expected to be as follows:

1. **Loss of biodiversity** – Wetlands support habitats that differ from the surrounding terrestrial habitats, and thus support a unique assemblage of species and are important in terms of biodiversity support. The disturbance to the wetlands within the opencast footprint, specifically the extensive cultivation of the hillslope seepage wetlands, has significantly reduced the biodiversity support function of the wetlands on site. The pans, though heavily impacted, still play a more important role in biodiversity support, specifically the south eastern pan where a rich birdlife was observed at the time of the survey, including a number of Greater Flamingo (listed as Near Threatened). The loss of a single pan, viewed in isolation, is unlikely to impact significantly on biodiversity at a regional scale. However, given the large number of mining applications within the area, the cumulative impact of wetland loss does need to be considered.
2. **Decreased water yield to downstream wetlands** – Pans, being inwardly draining, do not generally contribute significant water volumes to downstream wetland systems, and the

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loss of the pans is not expected to impact significantly on water yield to adjacent wetlands. Hillslope seepage wetlands are more typically considered to play a role in flow regulation, i.e. the temporary storage and slow release of flows to downslope wetlands and water courses. The hillslope seepage wetlands on site however, are characterised by generally shallow soils overlying ferricrete, limiting the volumes of water these systems can store. Lateral movement of water through the seepage wetlands is also expected to be minimal, further decreasing the importance of these wetlands in contributing flow to downstream wetlands. Most of the water supporting the hillslope seepage wetlands on site is expected to be lost to evapotranspiration. A possible exception is the north eastern hillslope seepage wetland, though the increased saturation of this wetland could be a result of increased seepage of water out of the pan due to the storage of groundwater in the pan.

3. **Loss of wetland ecosystem functions** – Wetlands are generally considered to perform a number of ecosystem services, ranging from flood attenuation and water quality enhancement, to biodiversity support and direct human benefits (e.g. provision of natural resources). In the case of the wetlands on site, the most important function performed by the pans is that of biodiversity support (addressed under point 1 above). The hillslope seepage wetlands are considered to be most important in terms of water quality maintenance, though the limited role they are expected to play in discharging flow to downstream wetlands also limits the significance of this function. Under natural conditions, they would also have been important in terms of biodiversity support, but currently only play a role in supporting productivity, i.e. crop cultivation.
4. **Deterioration in water quality** – Post-mining, the backfilled voids are likely to fill with water and start decanting. Decanting water is likely to be acidic as well as metal (e.g. Aluminium and Iron) and sulphate rich, resulting in significant deterioration of water quality within the Bronkhorstspruit to the east of the opencast pits. Currently, due to the absence of mining activities within the Bronkhorstspruit upstream of the R50 road crossing, the water quality at this point within the Bronkhorstspruit is still good, though agricultural impacts are evident.

Figure 22 shows the delineated wetlands with a 500m buffer zone. According to GN1199 of 18 December 2009, all activities taking place within a 500m radius of any wetland require a Water Use License in terms of water uses 21(c) and (i).

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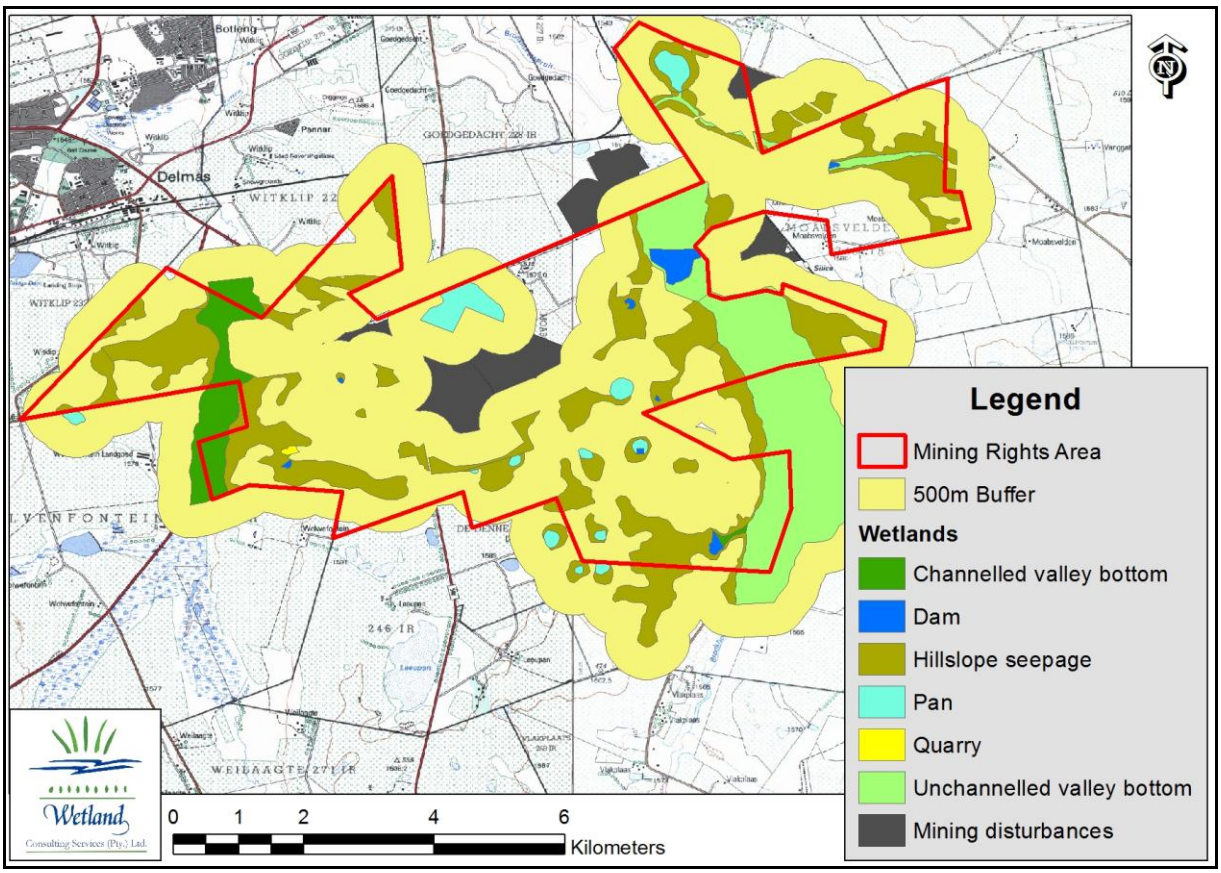


Figure 23: Map showing the delineated wetlands on site with a 500m buffer. Any activity proposed within the buffer area will require authorisation under a Water Use License.

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APPENDIX 1:

List of diatom species and associated abundances per site in April 2012.

Taxa	Sites				
	LP2	LP3	LP4	LP5	LP6
ACHNANTHIDIUM F.T. Kützing	0	1	0	88	115
ACHNANTHES J.B.M. Bory de St. Vincent	27	0	65	0	0
Achnanthidium exiguum (Grunow) Czarnecki	7	0	0	0	0
Amphora inariensis Krammer	0	0	0	0	6
Amphora montana Krasske	0	0	0	0	2
AMPHORA C.G. Ehrenberg ex F.T. Kützing	0	0	0	1	0
Amphora pediculus (Kützing) Grunow	77	0	0	0	0
Aulacoseira granulata (Ehr.) Simonsen var.angustissima (O.M.)Simonsen	0	2	6	4	0
Aulacoseira granulata (Ehr.) Simonsen	22	0	0	0	0
Caloneis bacillum (Grunow) Cleve	4	0	6	3	0
Cymbella cymbiformis Agardh	0	0	0	3	0
Cyclostephanos dubius (Fricke) Round	0	0	0	6	0
Craticula halophila (Grunow ex Van Heurck) Mann	4	0	0	0	0
Cyclostephanos invisitatus(Hohn & Hellerman)Theriot Stoermer & Hakans	60	0	0	0	0
Cyclotella meneghiniana Kützing	6	0	1	3	0
Caloneis molaris (Grunow) Krammer	0	0	0	3	0
COCCONEIS C.G. Ehrenberg	0	0	0	2	0
Cocconeis placentula Ehrenberg var.lineata (Ehr.)Van Heurck	0	0	0	0	5
Craticula accomoda (Hustedt) Mann	0	3	0	0	0
CRATICULA A. Grunow	0	0	0	1	0
Craticula cuspidata (Kützing) Mann	0	0	1	0	0
Cymatopleura solea (Brebisson) W.Smith var.apiculata (W.Smith) Ralfs	0	0	0	1	0
Cymbella tumida (Brebisson)Van Heurck	0	0	0	1	1
Craticula vixnegligenda Lange-Bertalot	0	0	0	2	0
CYCLOTELLA F.T. Kützing ex A de Brébisson	0	0	5	0	2
CYMBELLA C.Agardh	0	0	2	0	0
DIPLONEIS C.G. Ehrenberg ex P.T. Cleve	0	0	0	1	15
Epithemia adnata (Kützing) Brebisson	0	0	3	14	1
Encyonema minutum (Hilse in Rabh.) D.G. Mann	3	13	6	1	0
Eolimna Archibaldi	18	0	0	0	0
Eolimna minima(Grunow) Lange-Bertalot	1	7	1	10	10
Eolimna subminuscula (Manguin) Moser Lange-Bertalot & Metzeltin	0	5	0	0	5
Epithemia sorex Kützing	24	0	0	0	26
EUNOTIA C.G. Ehrenberg	0	0	1	0	0
Fragilaria biceps (Kützing) Lange-Bertalot	0	0	0	6	0
Fragilaria capucina Desmazieres var.vaucheriae(Kützing)Lange-Bertalot	5	0	0	0	0
Fragilaria nanana Lange-Bertalot	0	0	1	29	0
Fallacia pygmaea (Kützing) Stickle & Mann ssp.pygmaea Lange-Bertalot	0	0	0	1	2
Fragilaria tenera (W.Smith) Lange-Bertalot	1	0	2	0	0

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Fragilaria ulna (Nitzsch.)Lange-Bertalot var.acus (Kütz.) Lange-Berta	0	36	0	0	0
Gomphonema affine Kützing	3	0	0	0	0
Gomphonema exilissimum(Grun.) Lange-Bertalot & Reichardt	7	2	0	0	1
Gomphonema gracile Ehrenberg	0	12	0	2	0
GOMPHONEMA C.G. Ehrenberg	0	0	1	0	5
Gomphonema parvulum (Kützing) Kützing var. parvulum f. parvulum	0	175	0	4	0
Gomphonema pseudoaugur Lange-Bertalot	0	4	0	0	0
Gyrosigma scalproides (Rabenhorst)Cleve	0	0	0	1	0
Gyrosigma acuminatum (Kützing)Rabenhorst	0	0	0	0	1
Gyrosigma attenuatum	0	0	0	27	0
Mayamaea atomus (Kützing) Lange-Bertalot	0	0	0	6	2
Mayamaea atomus var. permitis (Hustedt) Lange-Bertalot	2	0	34	0	5
Nitzschia acidoclinata Lange-Bertalot	0	0	3	0	0
Nitzschia acicularis(Kützing) W.M.Smith	0	0	15	0	0
Nitzschia amphibia Grunow f.amphibia	0	2	0	0	0
Navicula antonii Lange-Bertalot	0	3	0	0	0
Navicula arvensis Hustedt var.maior Manguin in Bourrelly & Manguin	0	0	1	0	1
NAVICULA J.B.M. Bory de St. Vincent	0	3	10	0	1
Nitzschia bacillum Hustedt	12	0	0	0	23
Navicula capitatoradiata Germain	9	0	0	0	0
Navicula cryptocephala Kützing	0	5	15	0	2
Navicula cryptotenella Lange-Bertalot	2	0	0	1	2
Nitzschia dissipata(Kützing)Grunow var.dissipata	0	0	0	1	0
Nitzschia dissipata(Kützing)Grunow var.media (Hantzsch.) Grunow	0	0	0	18	16
Navicula erifuga Lange-Bertalot	0	4	3	0	0
Nitzschia fonticola Grunow in Cleve et Möller	22	0	0	0	14
Navicula heimansioides Lange-Bertalot	0	0	0	0	3
Nitzschia archibaldii Lange-Bertalot	0	0	50	15	7
Nitzschia intermedia Hantzsch ex Cleve & Grunow	0	11	0	2	0
Nitzschia pura Hustedt	0	2	0	1	0
NITZSCHIA A.H. Hassall	34	6	24	14	14
Nitzschia liebetruthii Rabenhorst var.liebetruthii	3	2	0	0	0
Navicula libonensis Schoeman	0	0	1	3	2
Nitzschia linearis(Agardh) W.M.Smith var.linearis	0	0	6	0	0
Nitzschia linearis(Agardh) W.M.Smith var.subtilis(Grunow) Hustedt	0	0	17	3	0
Navicula microcari Lange-Bertalot	0	0	0	0	5
Nitzschia microcephala Grunow in Cleve & Moller	0	0	0	1	0
Nitzschia nana Grunow in Van Heurck	1	0	4	0	0
Nitzschia paleacea (Grunow) Grunow in van Heurck	1	0	0	0	0
Nitzschia palea (Kützing) W.Smith	10	21	89	13	8
Navicula radiosa Kützing	0	0	0	0	9
Navicula reichardtiana Lange-Bertalot var. reichardtiana	0	0	0	4	0
Navicula riediana Lange-Bertalot & Rumrich	2	11	0	0	0
Navicula rostellata Kützing	4	0	9	2	0
Navicula schroeteri Meister var. schroeteri	0	0	0	0	9
Navicula symmetrica Patrick	2	50	0	0	0

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Navicula tenelloides Hustedt	1	0	0	10	7
Navicula trivialis Lange-Bertalot var. trivialis	0	8	0	20	2
Navicula vandamii Schoeman & Archibald var. vandamii	15	0	8	16	5
Navicula veneta Kützing	0	3	2	0	2
Navicula zanoni Hustedt	0	0	1	0	2
Pinnularia borealis Ehrenberg var. borealis	1	0	0	0	0
Pinnularia gibba Ehrenberg	0	0	0	2	0
PINNULARIA C.G. Ehrenberg	0	1	2	0	0
Planothidium frequentissimum(Lange-Bertalot)Lange-Bertalot	1	0	0	5	9
Pinnularia microstauron (Ehr.) Cleve var. rostrata Krammer	0	0	1	0	0
Placoneis placentula (Ehr.) Heinzerling	1	0	0	1	0
Planothidium rostratum (Oestrup) Lange-Bertalot	1	0	1	18	1
Pinnularia viridiformis Krammer var. minor Krammer	2	0	0	0	0
Pinnularia viridis (Nitzsch) Ehrenberg var.viridis morphotype 1	0	0	0	2	0
Rhopalodia gibba (Ehr.) O.Muller var.gibba	0	0	2	17	15
Simonsenia delognei Lange-Bertalot	0	0	0	0	14
Sellaphora pupula (Kützing) Mereschkowksy	1	7	1	2	0
Sellaphora seminulum (Grunow) D.G. Mann	0	0	0	0	15
Tryblionella calida (grunow in Cl. & Grun.) D.G. Mann	0	1	0	2	0
Tryblionella hungarica (Grunow) D.G. Mann	4	0	0	7	8

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APPENDIX 2:

Agrostis lachnantha
Amaranthus thunbergii
Andropogon appendiculatus
Andropogon eucomus
Aponogeton distachyos
Arctotis arctotoides
Aristida junciformis
Arundinella nepalensis
Berkheya carlinopsis
Berkheya pinnatifida
Berkheya radula
Berula erecta
Bidens bipinnata
Bidens formosa
Bidens pilosa
Calamagrostis epigeios
Carex sp.
Centella asiatica
Chamaecrista mimosoides
Chenopodium album
Chloris virgata
Cirsium vulgare
Commelina africana
Conyza canadensis
Cordylogyne globosa
Crepis hypochoerida
Crinum bulbispermum
Cyanotis speciosa
Cymbopogon plurinodis
Cynodon dactylon
Cyperus denudatus
Cyperus esculentus
Cyperus obtusiflora
Cyperus rigidifolius
Cyperus rupestris
Cyperus species
Datura stramonium
Denekia capensis
Digitaria eriantha
Echinochloa crus-galli
Eleocharis dregeana
Eleocharis sp.
Eragrostis capensis
Eragrostis chloromelas
Eragrostis curvula
Eragrostis gummiflua
Eragrostis plana
Eragrostis planiculmis
Eragrostis racemosa
Erythrina zeyheri
Eucalyptus sp.
Eucomis autumnalis

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Euphorbia striata
Fimbristylis complanata
Fingerhuthia africana
Fuirena pubescens
Gladiolus crassifolius
Haplocarpha lyrata
Haplocarpha scaposa
Harpochloa falx
Helichrysum aureonitens
Helichrysum rugulosum
Helichrysum setosum
Helictotrichon turgidulum
Hemarthria altissima
Heteropogon contortus
Hyparrhenia dregeana
Hyparrhenia hirta
Hypoxis hemerocallidea
Hypoxis iridifolia
Hypoxis rigidula
Imperata cylindrica
Juncus kraussii
Kyllinga erecta
Lagarosiphon major
Ledebouria ovatifolia
Leersia hexandra
Mariscus congestus
Monopsis decipiens
Nidorella anomala
Oenothera rosea
Oxalis depressa
Panicum schinzii
Panicum sp.
Paspalum dilatatum
Paspalum distichum
Paspalum urvillei
Pennisetum clandestinum
Pennisetum sphacelatum
Persicaria lapathifolia
Phragmites australis
Plantago lanceolata
Pseudognaphalium luteo-album
Pycreus macranthus
Ranunculus multifidus
Roripa nudiuscula
Rumex crispus
Schoenoplectus corymbosus
Schoenoplectus decipiens
Scirpus burkei
Senecio consanguineus
Senecio inaequidens
Senecio sp.
Setaria incrassata
Setaria nigrirostris
Setaria pallide-fusca

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Setaria sphacelata
Sonchus species
Sporobolus africanus
Stoebe vulgaris
Tagetes minuta
Themeda triandra
Tolpis capensis
Tristachya leucothrix
Typha capensis
Verbena bonariensis
Wahlenbergia undulate
Walafrida densiflora
Zea mays

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APPENDIX 3:

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Annexure H
Quarterly Water Quality Report



QUARTERLY WATER QUALITY REPORT

EXXARO Coal Mpumalanga (Pty) Ltd., Leeuwpan Coal Mine, located near Delmas, Mpumalanga Province.



PREPARED FOR:	EXXARO COAL MPUMALANGA (PTY) LTD. LEEUWPAN COAL MINE
PREPARED BY:	ENVASS
MONTH:	SEPTEMBER 2020
REPORT NUMBER:	MON-WQR-080-19_20 (20-09)
VERSION:	0.0

"Your Partner in Calculating Environmental Solutions"
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ENVIRONMENTAL ASSURANCE (Pty)Ltd

DOCUMENT CONTROL	
Document Title	Exxaro Leeuwpan Quarterly Water Quality Report
Report Number	MON-WQR-080-19_20 (20-09)
Version	0.0
Date	September 2020
Submitted to	Lucy Mogakane Environmental Practitioner Lucy.Mogakane@exxaro.com
Distribution	EXXARO Coal Mpumalanga (Pty) Ltd. Environmental Assurance (Pty) Ltd.

QUALITY CONTROL		
	Originated By	**Technical Review**
Name	Wian Esterhuizen	Anton Botha
Designation	Environmental Consultant	Environmental Consultant
Signature		
Date	12-10-2020	16-10-2020

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EXECUTIVE SUMMARY

Environmental Assurance (Pty) Ltd. (ENVASS) is appointed by EXXARO Coal Mpumalanga (Pty) Ltd. to implement and maintain an environmental compliance monitoring programme at the Leeuwpan Coal Mine, located near Delmas, Mpumalanga Province.

The water quality monitoring program was initiated at Leeuwpan Coal Mine as per the Water Use License requirements, including; surface- and groundwater sampling as well as reporting requirement. The water quality is conducted on the following sampling frequency: surface water localities are monitored on a monthly basis, while groundwater localities are monitored quarterly through purging, including the measurement of groundwater levels.

This report communicates the monthly water monitoring and results conducted within September 2020. All monitoring was conducted according to recognised standards and sent to a SANAS accredited laboratory for analysis as further described in this report.

The following findings pertain to the September 2020 surface water monitoring:

- Samples LSW06, LSW07, LSW08, LSW12, WP01, KR03, KR04, RD1, OWM PIT, OG PIT, OH PIT, OJ PIT, OM PIT, WLV PIT, OJ-O, OJ-S4-DISC, OH-WEATH, OL-OVB (2A+2B), LWP-SP-W and PIET-SCHUTTE could not be obtained during the monitoring period;
- The Load-out Bay Offices Water (LLBDW), Drinking Water Supply Tank (LDWST) and Drinking Water at Laboratory (LWDL) revealed elevated Heterotrophic Plate Counts which renders the water as not suitable for potable purposes. It should be noted that elevated *E.coli* was also present within the LLBDW locality;
- The majority of the receiving environment monitoring localities presented overall fair condition;
- Minor exceedances occurred at the process localities, while the majority of the monitoring point parameters were compliant to the stipulated WUL limits. All of the locallities exceeded the WUL limits for EC;
- The final effluent from LWP-SP-P was not active during the monitoring period, however historically recorded non-compliant to the set Wastewater WUL limits due to the exceedance of Ammonia, with the General Authorisation limits being exceeded in terms of Ammonia, Suspended Solids and COD. No access was available for LWP-SP-W; and
- During the monthly monitoring period of September 2020, the majority of the parameters analysed remained relatively constant with no major changes present compared to August 2020.

The following findings pertain to the September 2020 groundwater monitoring:

- Samples EMPR02/E2, KENMB1, KENMB2-D, KENMB3-S, LW08, LW10, LWG01, LWG04, MOAMB10, RIE10, RIE10B, RIE4, RKL03, WTN02-D, WWNMB 16 and WWN02D could not be obtained during the monitoring period;
- The majority of the monitoring boreholes recorded satisfactory concentrations compared to SANS241-1:2015; and
- From the monitoring results some boreholes presented elevated salinity and sulphate concentrations which may be attributed to the mining operation.

TABLE OF CONTENTS

1. INTRODUCTION 1
2. SYSTEMS AUDIT 1
3. PURPOSE 1
4. METHODOLOGY 3
5. SCOPE OF WORK 4
   5.1 LABORATORY ANALYSIS 4
   5.2 SURFACE WATER MONITORING 5
   5.3 GROUNDWATER MONITORING 7
6. RESULTS 14
   6.1 SURFACE WATER RESULTS 14
   6.2 GROUNDWATER RESULTS 35
7. DISCUSSION 40
   7.1 RECEIVING ENVIRONMENT WATER QUALITY 40
   7.2 PROCESS WATER QUALITY 41
   7.3 EFFLUENT WATER QUALITY 42
   7.4 POTABLE WATER QUALITY 42
   7.5 EXCEEDING VARIABLE DISCUSSION 43
   7.6 GROUNDWATER QUALITY 46
8. CONCLUSION AND ASPECTS TO CONSIDER 51

Appendix A – SAMPLING REGISTER 53

Appendix B – PROBE FIELD MEASUREMENTS 75

APPENDIX C – WATER MONITORING GRAPHS 76

RECEIVING ENVIRONMENT GRAPHS 76

PROCESS WATER GRAPHS 78

EFFLUENT WATER GRAPHS 81

POTABLE WATER GRAPHS 84

GROUNDWATER GRAPHS 87

LIST OF FIGURES

Figure 1: Leeuwpan Coal Mine Location Map 2
Figure 2: Receiving Environment Water Sampling Locality Map 9
Figure 3: Process Water Sampling Locality Map 10
Figure 4: Effluent Water Sampling Locality Map 11
Figure 5: Potable Water Sampling Locality Map 12
Figure 6: Groundwater Sampling Locality Map 13
Figure 7: Expanded Durov diagram of groundwater chemistry regarding March 2020 48
Figure 8: Stiff diagrams of groundwater chemistry regarding September 2020 49
Figure 9: Water levels measured at Exxaro Leeuwpan Operations March 2017 – September 2020 50
Figure 10: pH value 76
Figure 11: Electrical Conductivity 76
Figure 12: Total Dissolved Solids 77
Figure 13: Sulphate 77
Figure 14: *Escherichia coli* (*E.coli*) 78
Figure 15: pH value 78
Figure 16: Electrical Conductivity 79
Figure 17: Total Dissolved Solids 79
Figure 18: Sulphate 80
Figure 19: Oil and Grease 80
Figure 20: Nitrate 81
Figure 21: Suspended Solids 81
Figure 22: Ammonia 82
Figure 23: Nitrate 82
Figure 24: Ortho-Phosphate 83
Figure 25: Total Phosphate 83
Figure 26: Chemical Oxygen Demand (COD) 84
Figure 27: pH value 84
Figure 28: Turbidity 85
Figure 29: Electrical Conductivity 85
Figure 30: Heterotrophic Plate Count 86
Figure 31: Total Dissolved Solids 86
Figure 32: pH Value 87
Figure 33: Electrical Conductivity 87
Figure 34: Total Dissolved Solids (TDS) 88
Figure 35: Sulphates as SO_4 88

LIST OF TABLES

Table 1: Water Use License details 1
Table 2: Water quality parameters for Leeuwpan Coal Mine 4
Table 3: Surface Water Monitoring 6
Table 4: Groundwater Monitoring 7
Table 5: Receiving Environment Water Sample Results 14
Table 6: Process Water Sample Results 21
Table 7: Effluent Water Sample Results 28
Table 8: Potable Water Sample Results 30
Table 9: Groundwater Sample Results 35

GLOSSARY

A list of commonly used acronyms, measurement units and definitions are included below for the purpose of ensuring uniformity in the interpretation of this report:

Acronyms	
DWS	Department of Water and Sanitation (Formerly Department of Water Affairs and Forestry – DWAF and Department of Water Affairs - DWA)
EC	Electrical Conductivity
EMP	Environmental Management Programme
MDEDET	Mpumalanga Department of Economic Development, Environment and Tourism (Formerly Mpumalanga Department of Agriculture Land Administration – MDALA)
NEMA	National Environmental Management Act 107 of 1998
NWA	National Water Act 36 of 1998
PCD	Pollution control dam
SAR	Sodium Absorption Ratio
SHE	Safety, Health and Environment
WUL	Water Use License
Measurement Units	
Ha	Hectare
M	Meters
Mamsl	meters above mean sea level
Mbc	Meters below collar (of borehole)
mbgl	meters below ground level
mg/l	milligrams per litre
Definitions	
Borehole	A hole drilled for the purposes of prospecting i.e. extracting a sample of soil or rock chips by pneumatic, reverse air circulation percussion drilling, or any other type of probe entering the surface of the soil.
Pit	Any open excavation
Pollution control dam	A dam that forms part of a mine's water management system with the purpose to minimise the impact of polluted water on water resources, by separating clean and dirty water streams and capturing and retaining dirty water to prevent its discharge due to water quality constraints (DWAF, Best practice guideline A4: Pollution control dams, 2007).

1. INTRODUCTION

Environmental Assurance (Pty) Ltd. (ENVASS) was appointed by EXXARO Coal Mpumalanga (Pty) Ltd. to undertake the environmental compliance monitoring programme at Leeuwpan Coal Mine to fulfil the Water Use Licence Conditions (Licence no. **04/B20A/CIJ/4032**), approved on 18 December 2015.

The mining operation is located to the east of Delmas within the Victor Khanye Local Municipality. The mine is located within the Upper Olifants River Catchment. East of the mine, the Bronkhorstspruit flows as fed by a tributary running to the west of the mine. The underlying geology found in the area is comprised primarily of sedimentary rocks from the Karoo Supergroup with Dolerite intrusions featuring within the project area. The monthly and quarterly water quality monitoring at Leeuwpan Coal Mine consists out of the following, as per the Water Use License requirements; surface- and groundwater sampling.

The scope of work performed at the Leeuwpan Coal Mine is aligned to the WUL requirements, which are listed within the report.

2. SYSTEMS AUDIT

All monitoring points are presented within locality maps and are discussed under the relevant sections of this report. In all instances spatial scale was used in order to present the position of all of the monitoring points relative to the mine and associated infrastructure.

The descriptions below (**Table 1**) provide extracts from the amended approved Water Use Licence (IWUL) number **4/B21A/ABCGIJ/429** to describe the environmental monitoring for this site.

Table 1: Water Use License details

Water Use Licence details	
Authorisation:	4/B21A/ABCGIJ/429
Date:	18- December 2015
Licensee:	Leeuwpan Coal Mine
Competent Authority:	Department of Water and Sanitation
Water Use authorised:	Section 21 (a, c, i, g & j)

3. PURPOSE

The purpose of this report is to test and report on the operational compliance as it relates to water quality conditions set out in the WUL and management requirements from the approved Department of Mineral Resources (DMR) Environmental Management Programme (EMPr).

- Various water samples are taken and analysed from the provided surface- and groundwater localities.
- Surface water resources are monitored on a monthly basis, while groundwater samples are taken quarterly.

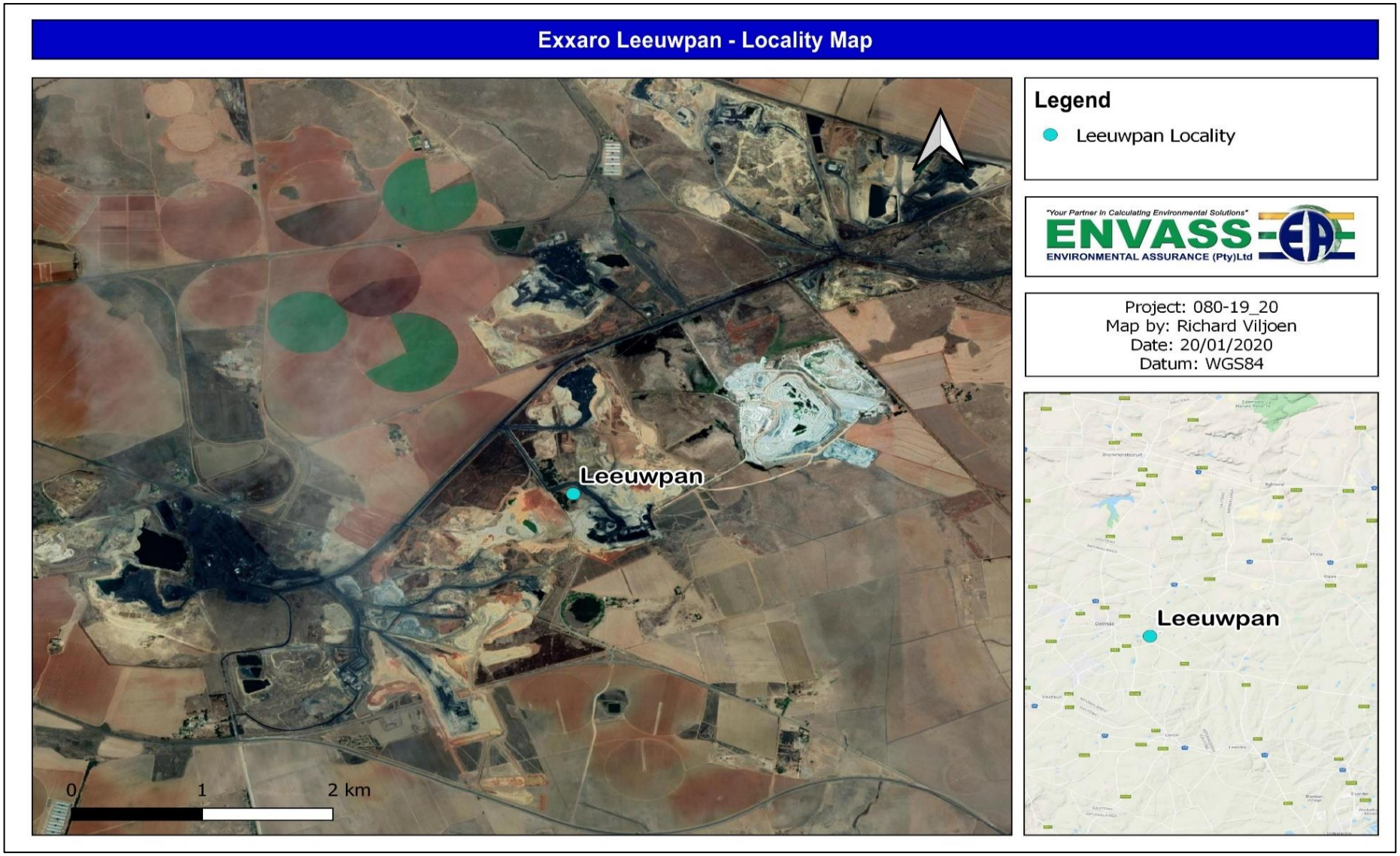


Figure 1: Leeuwpan Coal Mine Location Map

4. METHODOLOGY

All fieldwork is carried out by trained ENVASS environmental consultants and field technicians, fully trained in all of the methods of sampling as required. This includes as a minimum sampling for surface and groundwater.

Sampling at the selected Leeuwpan Coal sites will be in accordance with the following guidelines:

- Guidance on the design of sampling programs and sampling techniques

  ISO 5667-1:2006

- Guidance on the preservation and handling of water samples

  SANS 5667-3:2006/ISO 5667-3:2003

  (SABS ISO 5667-3)

- Guidance on sampling of drinking water from treatment works and piped distribution systems

  SANS 5667-5:2006/ISO 5667-5:2006

  (SABS ISO 5667-5)

- Guidance on sampling of rivers and streams

  SANS 5667-6:2006/ISO 5667-6:2005

  (SABS ISO 5667-6)

- Guidance on sampling of waste waters

  SANS 5667-10:2007/ISO 5667-10:1992

- Guidance on sampling of groundwater

  SANS 5667-11:1993/ISO 5667-11:1993

  (SABS ISO 5667-11)

- Guidance on quality assurance of environmental water sampling and handling

  SANS 5667-14:2016/ISO 5667-14:2014

- DWAF Best Practice Guidelines Series G3: General Guidelines for Water Monitoring Systems.

Water sampling locations are set out in the WUL and/or received from the mine and previous sampling reports; and ultimately these samples are used to identify areas of concern and areas from which water could effectively leave the site into some form of receiving environment.

This report is prepared by ENVASS, drawing from the following sources of information:

- Water Use License (**04/B20A/CIJ/4032**) (Process and Effluent Water Limits);
- General Authorisation Limits (Process and Effluent Water)
- SANS 241: 2015 standards (Potable Water);

- DWAF Domestic Target Water Quality (Surface Water as comparison);
- A site visit to the Leeuwpan and surrounding areas; and
- Result of water samples analysed.

5. SCOPE OF WORK

Leeuwpan Coal Mine's water quality is actively monitored as set out in the following water quality monitoring programme:

- Various water samples are taken and analysed from the provided surface- and groundwater localities.
- Surface water resources are monitored on a monthly basis, while groundwater samples are taken quarterly.

5.1 LABORATORY ANALYSIS

All sampled are submitted to a SANAS accredited laboratory, Yanka Laboratories (Accreditation No. T0647) and will be analysed according to ISO/IEC 17025:2005 standards. Annual triplicate samples will be submitted to Waterlab (Accreditation No. T0391) a third-party laboratory for quality assurance. The following packages form part of the monitoring at Leeuwpan Coal Mine:

Table 2: Water quality parameters for Leeuwpan Coal Mine

Parameters				
General Analysis Package	**Potable Water**	**Surface Water**	**Groundwater**	**Treated Sewage**
pH	X	X	X	
Electrical conductivity	X	X	X	
Total Dissolved Solids	X	X	X	
Suspended Solids				X
Total Hardness	X	X	X	
Total Alkalinity	X	X	X	
Calcium	X	X	X	
Magnesium	X	X	X	
Sodium	X	X	X	
Potassium	X	X	X	
Fluoride	X	X	X	
Chloride	X	X	X	
Sulphate	X	X	X	
Iron	X	X	X	
Manganese	X	X	X	
Aluminium	X	X	X	
Boron		X		
Copper			X	
Hexavalent Chromium		X		

Parameters				
General Analysis Package	**Potable Water**	**Surface Water**	**Groundwater**	**Treated Sewage**
Ammonia	X	X	X	X
Nitrate	X	X	X	X
Total inorganic nitrogen (TIN)		X		
Ortho-Phosphate	X	X	X	X
Total Phosphate		X		X
Chemical oxygen demand (total)				X
Turbidity (in-situ)	X	X		
DO (in-situ)	X	X		
Dissolved Organic Carbon		X		
Sodium adsorption ratio (SAR)	X			
Oil & grease		X		
Chlorophyll-a		X		
Bacteriological Analysis				
Escherichia coli (*E.coli*)	X	X		X
Faecal Coliforms				X
Heterotrophic plate count	X			
Trace Metal Analysis				
Al, As, B, Ba, Cd, Co, Cr, Cu, Fe, Mn, Mo, Ni, Pb, Se, Si, Sr, Ti, V, Zn, Hg, La, Lu, Sb, Sn, Th and Tl	X			

5.2 SURFACE WATER MONITORING

Surface water monitoring is performed at thirty-three (33) surface sampling points (See Table 3 and 5). Monitoring is performed on a monthly basis and is tested for the variables as listed in Table 2 (Refer to the WUL for surface water requirements). The monthly sampling register of the surface water localities indicated in Table 3 have been summarised in **Appendix A**.

Table 3: Surface Water Monitoring

Surface Water Monitoring			
Sample ID	**Description**	**Latitude**	**Longitude**
Potable Water			
LDWST	Drinking Water Supply Tank	S26.18005	E28.73602
LLBDW	Load-out Bay Offices Drinking Water	S26.16590	E28.72990
LWDL	Drinking Water at Laboratory	S26.17128	E28.72797
PIET-SCHUTTE	Drinking Water on Piet Schutte's Farm	S26.14150	E28.80170
River / Stream			
WP01	Bronkhorstspruit tributary, upstream	S26.17799	E28.70221
WP02	Bronkhorstspruit tributary, downstream	S26.15510	E28.70260
LSW03	Bronkhorstspruit at Delmas Silica, downstream	S26.16279	E28.76881
LSW05	Bronkhorstspruit, downstream	S26.13750	E28.75700
LSW06	Weltevredenspruit, upstream	S26.14390	E28.79550
LSW07	Bronkhorstspruit, upstream	S26.18860	E28.77635
LSW08	Bronkhorstspruit, upstream of Block OI	S26.23022	E28.76264
LSW12	Downstream of River Diversion 2, Between RD2 and LSW05	S26.13610	E28.76410
LSW13	Water from Stuart Coal	S26.14380	E28.77560
RD1	Bronkhorstspruit at haul road	S26.14930	E28.76450
Process Water			
KR01A	Kenbar Return Water Dam	S26.18087	E28.72995
KR03	Downstream of workshop oil separator sump	S26.18197	E28.73827
KR04	Marsh area next to workshop road	S26.18672	E28.73381
LSW09	Pollution Control Dam	S26.16601	E28.72541
ODN_PIT	OD Pit Water (closed pit)	S26.17122	E28.72381
OG_PIT	OG Pit Water (backfilled pit)	S26.17119	E28.73397
OH_PIT	OH Pit Water (backfilled pit)	S26.16698	E28.75338
OJ_PIT	OJ Pit Water	S26.16854	E28.74505
OM_PIT	OM Pit Water	S26.17278	E28.74875
OWM_PIT	OWM (Moabsvelden) Pit Water	S26.14440	E28.79241
WLV-PIT	Weltevreden Pit	S26.12888	E28.76050
WP04	New Witklip Return Water Dam	S26.17234	E28.70640
Final Effluent			

LWP_SP_P	Final effluent from septic tanks at plant	S26.1716	E28.7302
LWP_SP_W	Final effluent at sewage plant behind workshop	S26.1812	E28.7396
Additional Samples			
Kenbar rehab	Backfilled former Kenbar Pit	S26.1735	E28.7333
OJ-O	Field Barrels for experimental work	Unknow	
OJ-S4-DISC	Field Barrels for experimental work		
OH-WEATH	Field Barrels for experimental work		
OL-OVB(2A+2B)	Field Barrels for experimental work		

5.3 GROUNDWATER MONITORING

Groundwater monitoring is performed at thirty-six (36) borehole monitoring points (see Table 4). Monitoring is performed on a quarterly basis (March, June, September and December) and is tested for the variables as listed in Table 2 (Refer to the WUL for groundwater requirements). The monthly sampling register of the surface water localities indicated in Table 4 have been summarised in **Appendix A**.

Table 4: Groundwater Monitoring

Groundwater Monitoring			
Sample ID	**Description**	**Latitude**	**Longitude**
EMPR02/E2	West of ODN pit	S 26° 9.7314'	E 28°43.0668'
KENMB1	Fuel Dispensary	S 26° 10.9176'	E 28°44.2698'
KENMB2-D	Silver Dam 2	S 26°10.7604'	E 28°43.8452'
KENMB2-S	Silver Dam 1	S 26° 10.761'	E 28°43.827'
KENMB3-D	PLANT/Stockpile 1	S 26°10.1738'	E 28°44.2325'
KENMB3-S	PLANT/Stockpile 2	S 26°10.2819'	E 28°43.8080'
LEEMB18-D	Plant Conveyor 2	S 26°10.0902'	E 28°43.6521'
LW07	North of Witklip	S 26°09.9706'	E 28°42.6314'
LW08	South West of Kenbar	S 26O11.0940'	E 28°43.6227'
LW10	South of Delmas Silica (borehole does not exist)	S 26°9.8760'	E 28°45.90'
LWG01	South of Kenbar	S 26°10.7796'	E 28°43.7256'
LWG02	South East of Kenbar	S 26°10.7461'	E 28°44.2200'
LWG04	Moabsvelden Groundwater	S 26°10.4568'	E 28° 45.3546'
MOAMB10	Block OI New Mine Area 1	S 26°09.9010'	E 28°45.9177'
MOAMB4	Block OH	S 26°10.0472'	E 28°44.6280'
MOAMB7	Block OJ / Stuart Coal Upstream	S 26°09.2321'	E 28°45.3272'

Groundwater Monitoring			
Sample ID	**Description**	**Latitude**	**Longitude**
MOAMB9	Block OI New Mine Area2	S 26°10.5353'	E 28°46.0158'
RIE10	Rietkuil Monitoring Borehole	S 26°12.0996'	E 28°45.8058'
RIE10B	Rietkuil Monitoring Borehole	S 26°12.0783'	E 28°45.8202'
RIE4	Rietkuil Monitoring Borehole	S 26°11.3292'	E 28°46.104'
RKL01	Rietkuil Monitoring Borehole	S 26°11.0684'	E 28°44.6443'
RKL03	Rietkuil Monitoring Borehole	S 26°11.355'	E 28°46.248'
RKL04	De Denne Monitoring Borehole upstream of	S 26°11.8884'	E 28°44.5146'
RKL02	Rietkuil Monitoring Borehole	S 26°10.9936'	E 28°45.9942'
WELMB13-D	Moabsvelden 1	S 26°08.6306'	E 28°46.7083'
WELMB13-S	Moabsvelden 2	S 26°08.6364'	E 28°46.6961'
WITMB14	Block OA	S 26°10.0137'	E 28°42.3247'
WOLMB15-D	ODN/PCD1	S 26°09.9538'	E 28°43.4233'
WOLMB15-S	ODN/PCD 2	S 26°09.9548'	E 28°43.4306'
WTN02-D	Weltevreden Monitoring Borehole - Deep	S 26°8.7840'	E 28°46.1604'
WTN02S	Weltevreden Monitoring Borehole - Shallow	S 26°8.7840'	E 28°46.1598'
WTN01-D	Weltevreden Monitoring Borehole	S 26°8.0976'	E 28°45.942'
WTN01-S	Weltevreden Monitoring Borehole - Shallow	S 26° 8.0976'	E 28° 45.942'
WWNMB16	Block UB	S 26°10.7110'	E 28°42.6609'
WWN01	Wolwenfontein Monitoring Borehole	S 26° 10.4628'	E 28° 43.0332'
WWN02D	Wolwenfontein Monitoring Borehole - deep	S 26°10.4475'	E 28°43.0969'

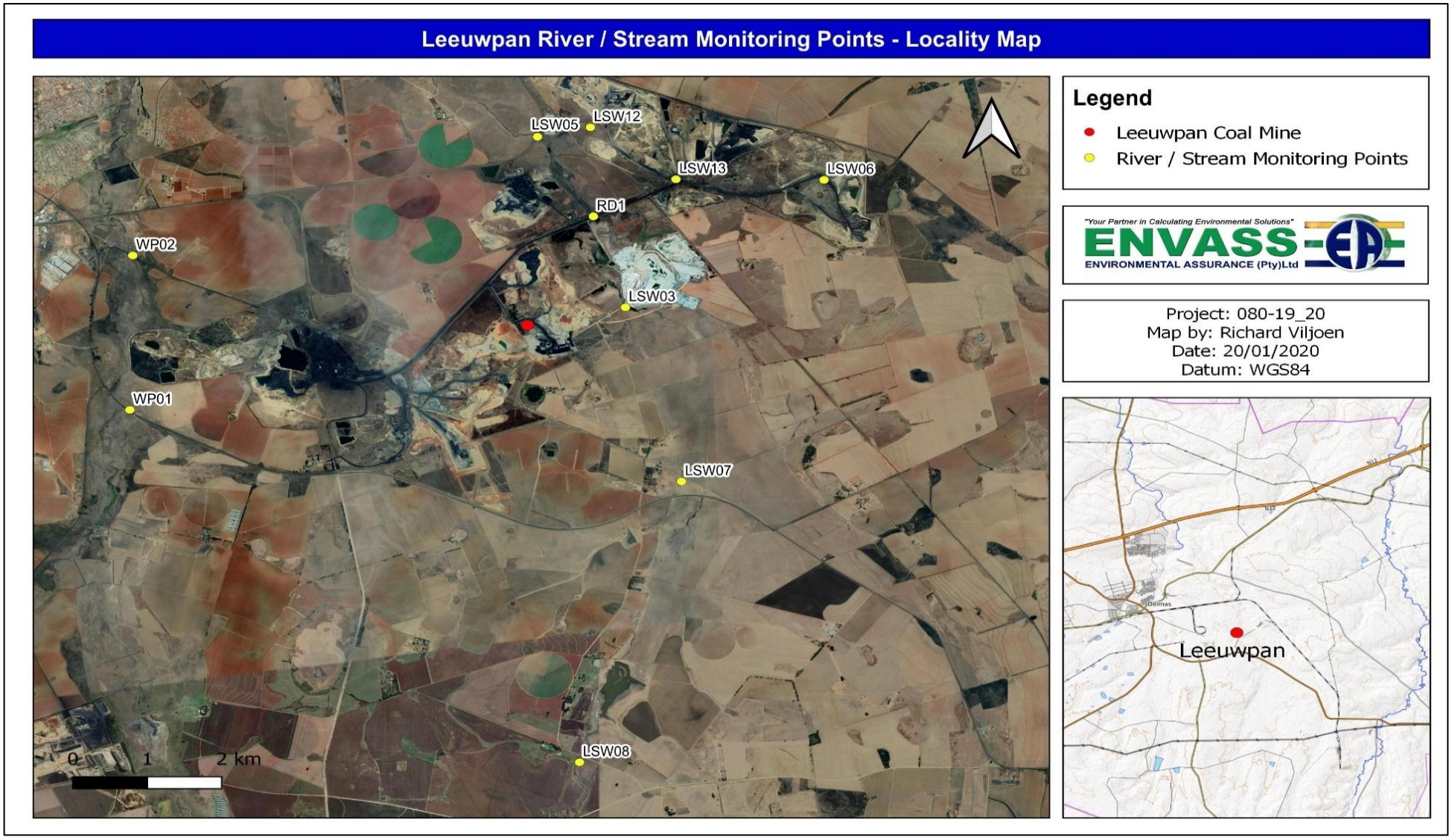


Figure 2: Receiving Environment Water Sampling Locality Map

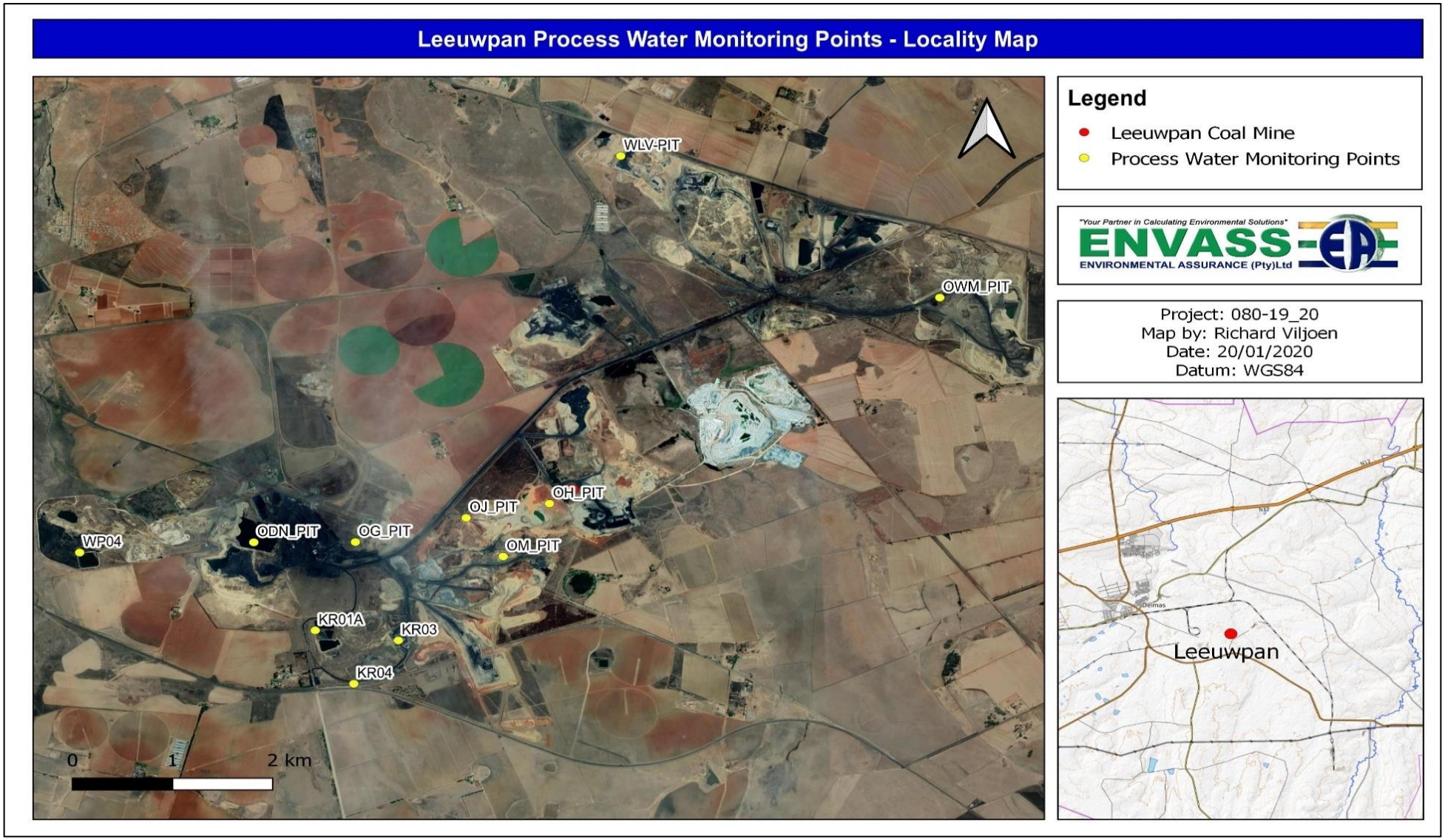


Figure 3: Process Water Sampling Locality Map

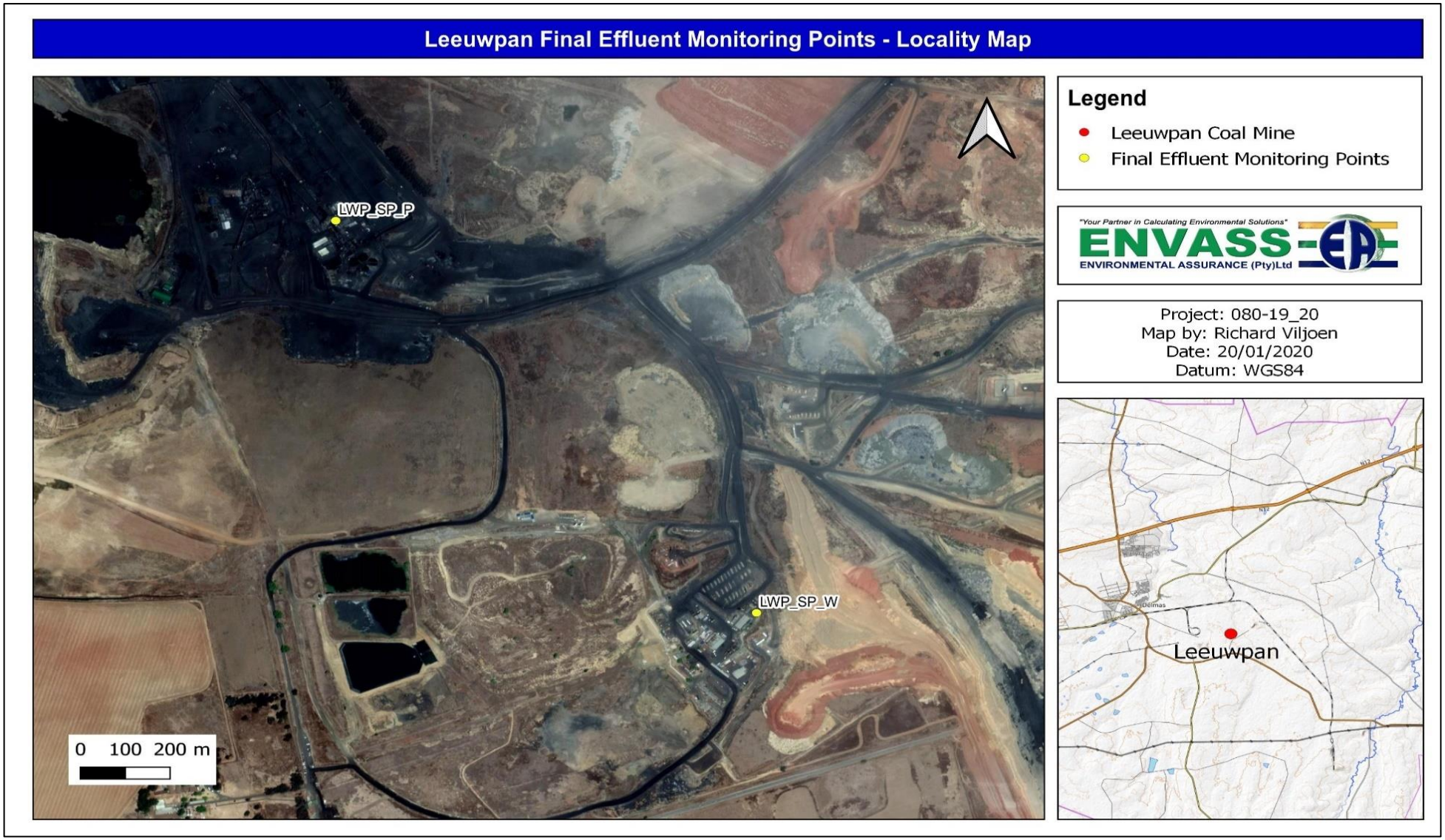


Figure 4: Effluent Water Sampling Locality Map

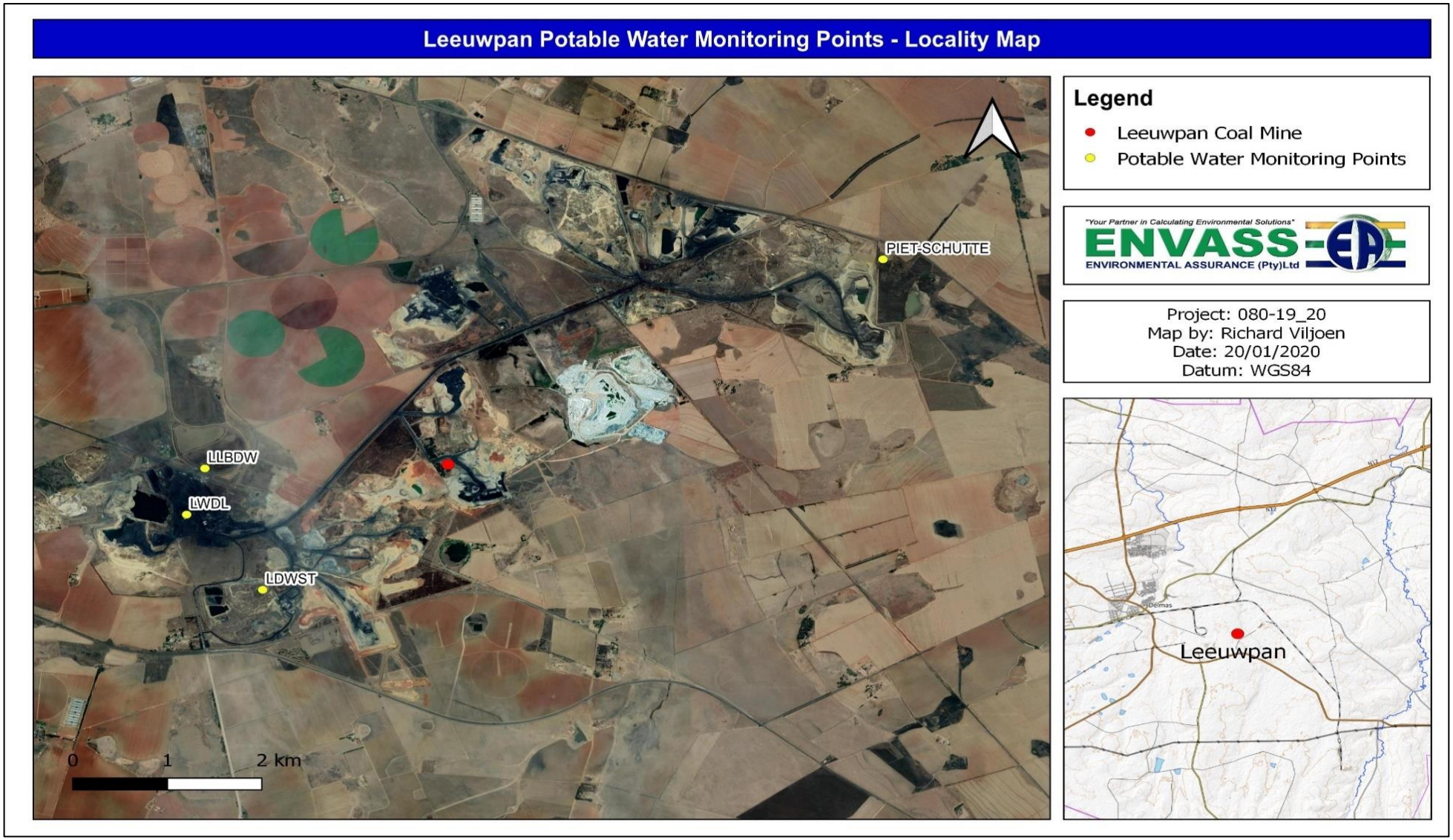


Figure 5: Potable Water Sampling Locality Map

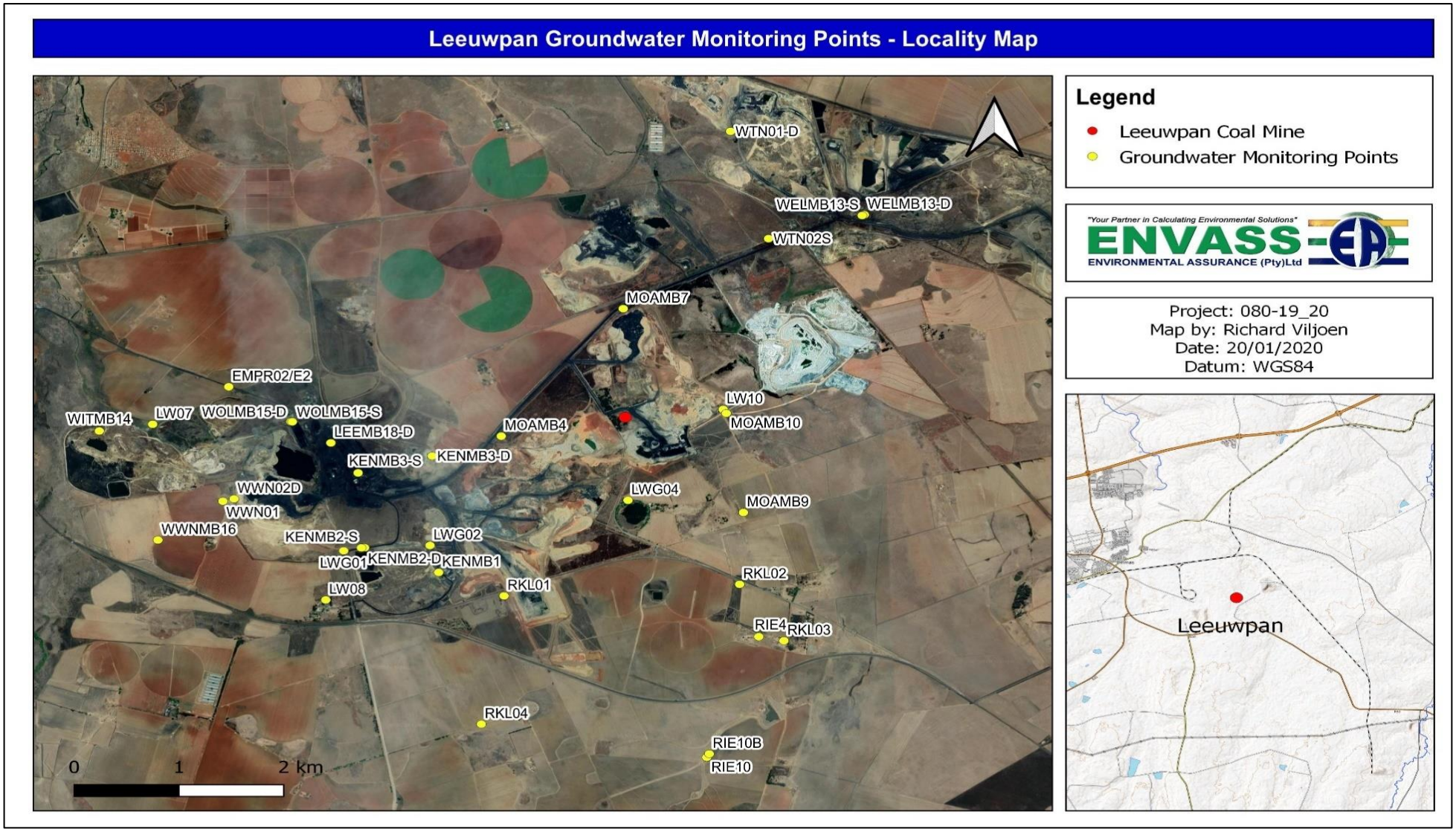


Figure 6: Groundwater Sampling Locality Map

6. RESULTS

6.1 SURFACE WATER RESULTS

Table 5: Receiving Environment Water Sample Results

Exxaro Leeuwpan																													
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Boron (B)	Hexavalent Chromium (Cr^{6})	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Total Inorganic Nitrogen (mg/l)	Ortho Phosphate as P (mg/l)	Total Phospahte	Turbidity	Dissolved Oxygen (DO)	Dissolved Organic Carbon (DOC)	Oil & Grease	Chlorofyll-a	*Escherichia coli* (*E.coli*)
DWAF Domestic Target Water Quality Range			6.0 - 9.0	70	450	-	-	32	30	100	50	1	100	200	0.1	0.05	0.15	-	0.050	1	6	-	-	-	1	-	5	-	1	0
Surface Water																													
WP01	15/10/2019	Dry																											
	21/11/2019	Dry																											
	05/12/2019	Dry																											
	16/01/2020	Dry																											
	06/02/2020	Dry																											
	09/03/2020	Dry																											
	08/05/2020	Dry																											
	19/05/2020		7.52	51.7	303	248	187	44.0	33.6	14.3	7.50	<0.09	12.4	79.4	0.04	0.02	0.03	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	1.42	4.83	6.50	19.1	0.80	<0.001	62
	02/06/2020		7.78	51.2	307	250	187	45.7	33.0	15.1	7.18	<0.09	12.7	81.3	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.50	18.40	7.61	16.6	0.60	<0.001	0
	07/07/2020		8.25	54.5	290	258	260	51.5	31.5	11.1	6.97	<0.09	12.6	20.4	0.03	0.02	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.16	10.90	7.53	19.2	3.33	0.03	2
	13/08/2020		8.02	48.1	289	244	258	51.4	28.0	17.6	3.30	<0.09	7.8	25.7	<0.01	0.47	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.20	8.00	7.36	12.3	1.50	0.002	2
	08/09/2020	Dry																											
WP02	15/10/2019		8.13	44.2	239	193	231	35.3	25.4	18.0	3.53	0.16	12.2	6.2	0.04	<0.01	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	<0.03	1.13	14.00	5.39	18.0	1.20	<0.001	0
	20/11/2019		7.78	44.0	220	173	188	30.6	23.4	17.0	4.06	0.15	9.2	22.8	<0.01	<0.01	<0.01	<0.01	<0.02	<0.45	<0.01	<0.45	<0.03	0.11	7.95	5.39	13.4	0.80	0.006	0
	05/12/2019		7.35	20.9	97	75	74	16.6	8.1	2.0	5.64	0.25	5.5	13.0	0.40	<0.01	0.84	0.02	<0.02	0.47	<0.35	0.47	<0.03	0.14	78.20	6.91	12.1	1.20	<0.001	8
	16/01/2020		7.86	42.3	216	186	198	32.3	25.6	14.6	4.24	0.14	10.0	9.0	0.14	0.06	0.41	0.02	<0.02	0.47	<0.35	<0.45	<0.03	0.19	28.30	6.18	12.8	0.90	0.01	3
	06/02/2020		7.94	47.6	244	219	198	43.8	26.6	11.6	1.53	0.10	4.1	37.1	<0.01	<0.01	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.06	22.10	7.66	10.6	2.40	0.014	8
	09/03/2020		7.73	46.6	262	232	224	48.4	26.9	10.6	2.31	0.10	5.3	34.1	0.01	<0.01	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.16	7.66	6.40	9.0	1.00	0.003	0
	08/05/2020		7.93	52.8	298	264	238	55.1	30.7	10.3	5.97	<0.09	13.1	39.5	0.11	0.06	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.10	8.28	6.55	18.1	1.80	0.01	0
	19/05/2020		7.97	52.8	302	267	231	53.5	32.5	14.2	4.97	<0.09	10.6	44.7	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	0.75	0.75	<0.03	0.03	3.89	6.92	17.7	0.80	<0.001	10
	02/06/2020		7.92	50.8	292	256	229	50.8	31.3	14.6	4.17	<0.09	10.0	39.7	<0.01	0.03	<0.01	<0.01	<0.01	<0.45	0.85	0.85	<0.03	0.58	7.80	7.58	13.3	0.60	0.001	0
	07/07/2020		7.93	53.7	279	235	218	46.8	28.6	13.5	5.20	<0.09	11.8	39.9	0.01	<0.01	<0.01	<0.01	<0.01	<0.45	0.64	0.64	<0.03	0.26	4.40	7.51	15.9	5.00	0.02	64
	13/08/2020		7.99	47.8	238	216	232	44.1	25.6	11.8	2.61	<0.09	7.8	6.5	<0.01	0.10	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.16	7.51	7.49	11.9	0.83	0.01	4
	08/09/2020		8.15	48.2	252	223	242	46.2	26.1	12.4	2.96	0.16	9.6	7.8	0.01	0.01	<0.01	<0.01	0.02	<0.45	0.39	<0.45	<0.03	0.64	14.20	7.41	13.0	0.80	<0.01	0

Exxaro Leeuwpan																														
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Boron (B)	Hexavalent Chromium (Cr^{6})	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Total Inorganic Nitrogen (mg/l)	Ortho Phosphate as P (mg/l)	Total Phospahte	Turbidity	Dissolved Oxygen (DO)	Dissolved Organic Carbon (DOC)	Oil & Grease	Chlorofyll-a	*Escherichia coli* (*E.coli*)
DWAF Domestic Target Water Quality Range			6.0 - 9.0	70	450	-	-	32	30	100	50	1	100	200	0.1	0.05	0.15	-	0.050	1	6	-	-	-	1	-	5	-	1	0
Surface Water																														
LSW03	15/10/2019		8.35	34.1	183	143	122	21.9	21.4	15.3	1.28	0.28	12.9	36.5	0.01	<0.01	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.10	5.27	5.23	13.0	4.00	<0.001	44
	21/11/2019		8.50	26.9	129	113	92	23.2	13.5	4.0	1.06	<0.09	6.2	26.0	<0.01	<0.01	<0.01	<0.01	<0.02	<0.45	0.01	<0.45	<0.03	0.24	68.30	5.36	11.4	2.80	0.033	0
	05/12/2019		6.81	25.6	128	95	71	22.6	9.4	4.9	5.44	0.23	8.7	33.7	<0.01	<0.01	<0.01	0.01	<0.02	<0.45	<0.35	<0.45	0.16	0.59	48.40	6.12	22.5	1.20	0.02	12
	16/01/2020		7.77	35.8	176	141	113	27.2	17.8	9.3	3.71	0.22	11.5	38.2	0.04	0.02	<0.01	0.02	<0.02	<0.45	<0.35	<0.45	0.16	0.21	23.00	5.92	14.2	1.30	0.02	4
	06/02/2020		7.17	24.8	115	74	79	14.2	9.3	13.2	2.49	0.31	19.9	5.9	0.26	0.43	<0.01	<0.01	<0.02	1.07	<0.35	1.07	<0.03	0.05	220.00	7.44	28.2	0.80	0.021	80
	09/03/2020		7.42	39.6	211	179	145	36.9	21.0	9.2	1.87	0.12	12.1	42.9	<0.01	<0.01	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.31	3.49	6.86	11.2	2.00	0.01	4
	08/05/2020		7.41	41.2	227	190	140	41.8	20.9	10.3	1.73	<0.09	14.7	53.2	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.44	3.91	6.80	16.3	1.20	0.03	0
	19/05/2020		7.40	43.6	249	209	149	40.2	26.3	12.4	1.82	<0.09	11.8	67.3	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.47	1.48	6.90	12.6	0.80	0.002	2
	02/06/2020		7.73	44.2	242	197	139	39.2	24.0	11.2	1.74	<0.09	13.0	69.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.50	2.30	7.64	10.7	1.20	0.01	0
	07/07/2020		8.18	34.7	178	131	111	20.9	19.2	15.0	4.90	<0.09	18.4	32.6	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.67	4.43	7.30	15.2	6.67	0.01	0
	13/08/2020		7.82	45.9	247	221	152	39.6	29.7	8.6	2.49	<0.09	12.5	63.3	0.03	0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.34	3.10	7.49	8.9	0.33	<0.001	2
	08/09/2020		8.15	40.9	219	185	142	36.8	22.5	12.5	3.64	0.26	17.7	40.5	0.02	<0.01	<0.01	0.01	0.02	<0.45	<0.35	<0.45	<0.03	0.95	4.82	7.58	16.3	2.00	0.01	0
LSW05	15/10/2019		7.76	53.8	272	226	209	36.8	32.6	17.0	4.61	0.19	21.1	35	0.01	<0.01	<0.01	0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.11	5.0	5.93	14.3	0.80	0.01	0
	20/11/2019		7.82	48.9	239	217	192	37.8	29.7	9.9	2.88	0.19	14.5	29	<0.01	0.05	<0.01	0.01	<0.02	<0.45	<0.01	<0.45	<0.03	0.13	3.2	5.53	18.5	2.80	<0.001	0
	05/12/2019		7.38	47.4	254	220	161	48.0	24.3	7.5	5.54	0.19	10.7	61	<0.01	<0.01	<0.01	0.03	<0.02	<0.45	<0.35	<0.45	<0.03	0.06	3.7	6.80	19.3	0.80	<0.001	20
	16/01/2020		7.67	50.9	267	225	180	42.2	29.0	11.7	5.35	0.18	18.3	52	0.07	0.03	0.19	0.02	<0.02	<0.45	<0.35	<0.45	<0.03	0.10	9.0	6.18	15.1	1.10	0.02	12
	06/02/2020		7.45	35.4	167	142	141	29.5	16.7	9.2	1.70	0.21	13.6	12	0.04	0.22	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.05	12.4	7.21	20.2	1.20	0.003	36
	09/03/2020		7.39	43.3	223	186	156	38.4	21.8	11.8	4.89	0.20	17.8	34	<0.01	0.03	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	0.14	0.50	5.7	6.47	17.4	1.20	0.01	2
	08/05/2020		7.56	41.1	220	187	128	40.0	21.1	8.6	4.45	<0.09	16.4	53	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.29	56.3	6.29	13.6	1.60	<0.001	22
	19/05/2020		7.70	42.2	248	203	152	40.4	24.8	12.1	3.76	<0.09	13.0	63	<0.01	<0.01	0.02	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.19	2.1	6.38	13.9	0.80	<0.001	44
	02/06/2020		7.93	43.3	244	198	136	39.4	24.2	11.0	2.54	<0.09	12.9	73	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.75	6.4	7.73	9.9	1.00	0.003	0
	07/07/2020		8.01	45.2	243	196	139	40.5	23.0	9.9	3.60	<0.09	14.8	68	0.04	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.30	16.1	7.53	8.9	2.78	0.02	6
	13/08/2020		7.99	45.7	245	197	158	40.2	23.4	10.2	3.79	<0.09	13.5	59	0.10	0.01	0.04	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.55	16.6	7.66	10.1	0.33	<0.001	0
	08/09/2020		8.03	48.5	264	216	189	43.1	26.4	12.5	4.91	0.13	17.1	46	0.03	<0.01	<0.01	0.02	0.02	<0.45	<0.35	<0.45	<0.03	0.27	12.8	7.70	14.1	1.20	<0.01	0

Exxaro Leeuwpan																													
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Boron (B)	Hexavalent Chromium (Cr^{6})	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Total Inorganic Nitrogen (mg/l)	Ortho Phosphate as P (mg/l)	Total Phospahte	Turbidity	Dissolved Oxygen (DO)	Dissolved Organic Carbon (DOC)	Oil & Grease	Chlorofyll-a	*Escherichia coli* (*E.coli*)
DWAF Domestic Target Water Quality Range			6.0 - 9.0	70	450	-	-	32	30	100	50	1	100	200	0.1	0.05	0.15	-	0.050	1	6	-	-	-	1	-	5	-	1	0
Surface Water																													
LSW06	15/10/2019	Dry																											
	21/11/2019	Dry																											
	05/12/2019	Dry																											
	16/01/2020	Dry																											
	06/02/2020	Dry																											
	09/03/2020	Dry																											
	08/05/2020	Dry																											
	19/05/2020	Dry																											
	02/06/2020	Dry																											
	07/07/2020	Dry																											
	13/08/2020	Dry																											
	07/09/2020	Dry																											
LSW07	15/10/2019	Dry																											
	21/11/2019	Dry																											
	05/12/2019	Dry																											
	16/01/2020	Dry																											
	06/02/2020	Dry																											
	09/03/2020	Dry																											
	08/05/2020	Dry																											
	19/05/2020	Dry																											
	02/06/2020	Dry																											
	07/07/2020	Dry																											
	13/08/2020	Dry																											
	07/09/2020	Dry																											

Exxaro Leeuwpan																													
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Boron (B)	Hexavalent Chromium (Cr^{6})	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Total Inorganic Nitrogen (mg/l)	Ortho Phosphate as P (mg/l)	Total Phospahte	Turbidity	Dissolved Oxygen (DO)	Dissolved Organic Carbon (DOC)	Oil & Grease	Chlorofyll-a	*Escherichia coli* (*E.coli*)
DWAF Domestic Target Water Quality Range			6.0 - 9.0	70	450	-	-	32	30	100	50	1	100	200	0.1	0.05	0.15	-	0.050	1	6	-	-	-	1	-	5	-	1	0
Surface Water																													
LSW08	15/10/2019	Dry																											
	21/11/2019	Dry																											
	05/12/2019	Dry																											
	16/01/2020	Dry																											
	06/02/2020	Dry																											
	09/03/2020	Dry																											
	08/05/2020	Dry																											
	19/05/2020	Dry																											
	02/06/2020	Dry																											
	07/07/2020	Dry																											
	13/08/2020	Dry																											
	07/09/2020	Dry																											
LSW12	15/10/2019	Dry																											
	21/11/2019	No Access																											
	05/12/2019	Dry																											
	16/01/2020	Dry																											
	06/02/2020	Dry																											
	09/03/2020	Dry																											
	08/05/2020	Dry																											
	19/05/2020	Dry																											
	02/06/2020	Dry																											
	07/07/2020	Dry																											
	13/08/2020	Dry																											
	07/09/2020	Dry																											

Exxaro Leeuwpan																													
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Boron (B)	Hexavalent Chromium (Cr^6)	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Total Inorganic Nitrogen (mg/l)	Ortho Phosphate as P (mg/l)	Total Phospahte	Turbidity	Dissolved Oxygen (DO)	Dissolved Organic Carbon (DOC)	Oil & Grease	Chlorofyll-a	*Escherichia coli* (*E.coli*)
DWAF Domestic Target Water Quality Range			6.0 - 9.0	70	450	-	-	32	30	100	50	1	100	200	0.1	0.05	0.15	-	0.050	1	6	-	-	-	1	-	5	-	1	0
Surface Water																													
LSW13	15/10/2019		7.15	296	2780	1927	41	356.0	252.0	62.3	18.10	0.31	25.3	2041	0.02	<0.01	<0.01	0.18	<0.02	<0.45	<0.35	<0.45	<0.03	0.13	74.1	5.39	14.50	4.80	<0.001	2
	21/11/2019		6.80	47	301	199	11	43.2	22.1	1.3	7.11	0.20	3.6	207	0.18	1.30	0.56	0.01	<0.02	1.95	0.02	3	0.24	0.39	33.8	5.41	6.40	0.80	<0.001	14
	05/12/2019		6.93	78	545	404	19	89.5	43.9	5.8	8.86	0.16	14.7	368	<0.01	<0.01	<0.01	0.04	<0.02	<0.45	0.46	0.48	<0.03	<0.03	18.5	6.42	12.50	1.20	<0.001	0
	16/01/2020		7.10	168	1436	1011	34	186.0	133.0	29.6	11.80	0.25	15.3	1032	0.08	0.45	0.48	0.09	<0.02	1.95	0.75	0.77	0.24	0.25	54.9	6.12	11.10	1.80	0.01	0
	06/02/2020		7.60	29	155	121	33	26.6	13.2	1.8	1.52	0.27	1.5	91	<0.01	<0.01	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.05	19.5	7.64	5.25	2.40	<0.001	2
	09/03/2020		7.22	53	329	246	41	48.0	30.7	6.9	3.02	0.14	17.6	198	<0.01	0.01	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.15	8.1	6.42	5.52	1.50	0.005	2
	08/05/2020		7.17	43	283	203	38	41.8	23.9	5.0	5.89	<0.09	11.7	172	<0.01	0.22	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.32	21.8	6.30	16.20	1.20	0.03	0
	19/05/2020		7.29	44	285	207	39	37.7	27.4	9.0	5.98	<0.09	12.9	169	<0.01	0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.10	15.5	6.19	8.80	1.00	<0.001	0
	02/06/2020		7.65	46	291	208	37	39.4	26.5	8.4	5.24	<0.09	15.1	174	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.98	12.2	7.63	6.52	1.00	<0.001	0
	07/07/2020		7.86	47	302	210	34	38.9	27.5	8.6	4.06	<0.09	14.4	186	0.01	<0.01	<0.01	<0.01	<0.01	<0.45	0.40	<0.45	<0.03	0.98	108.0	7.48	5.12	1.33	0.002	0
	13/08/2020		7.47	48	292	215	31	36.5	30.1	6.5	4.07	0.13	15.7	180	0.01	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.16	11.0	7.70	5.68	1.50	<0.001	6
	08/09/2020		7.36	53	343	243	30	40.7	34.4	9.1	4.04	0.15	18.0	218	0.09	0.22	0.04	<0.01	0.02	<0.45	<0.35	<0.45	<0.03	0.48	7.1	7.68	6.94	3.00	0.01	0
RD1	15/10/2019	Dry																											
	21/11/2019		7.49	42	197	167	157	33.6	20.3	9.1	3.81	0.17	12.7	23	0.08	0.07	<0.01	<0.01	<0.02	<0.45	<0.01	<0.45	0.06	0.17	14.3	5.76	19.30	0.80	0.003	6
	05/12/2019		7.42	42	226	194	136	43.1	20.9	6.8	5.56	0.18	11.5	54	<0.01	<0.01	<0.01	0.02	<0.02	<0.45	0.41	<0.45	0.06	0.14	40.8	6.91	20.00	1.60	<0.001	0
	16/01/2020		7.46	42	205	190	146	37.6	23.3	8.3	4.69	0.16	12.5	37	0.08	0.07	<0.01	0.02	<0.02	<0.45	0.41	<0.45	0.06	0.16	25.8	6.28	18.50	0.70	<0.001	0
	06/02/2020	Dry																											
	09/03/2020	Dry																											
	08/05/2020	Dry																											
	19/05/2020	Dry																											
	02/06/2020	Dry																											
	07/07/2020	Dry																											
	13/08/2020	Dry																											
	07/09/2020	Dry																											

Exxaro Leeuwpan																														
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Boron (B)	Hexavalent Chromium (Cr^6)	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Total Inorganic Nitrogen (mg/l)	Ortho Phosphate as P (mg/l)	Total Phospahte	Turbidity	Dissolved Oxygen (DO)	Dissolved Organic Carbon (DOC)	Oil & Grease	Chlorofyll-a	*Escherichia coli* (*E.coli*)
DWAF Domestic Target Water Quality Range			6.0 - 9.0	70	450	-	-	32	30	100	50	1	100	200	0.1	0.05	0.15	-	0.050	1	6	-	-	-	1	-	5	-	1	0
Surface Water																														
Comparrison Samples																														
LSW03 A	08/05/2020		7.38	41	217	180	136	38.0	20.7	9.9	2.10	<0.09	14.2	51	0.01	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.36	4.7	6.61	14.90	0.40	0.01	0
	07/07/2020		8.10	35	177	127	111	20.5	18.4	13.8	4.50	<0.09	19.0	34	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.41	3.9	7.29	14.70	5.56	0.01	0
	13/08/2020		7.79	47	249	216	153	39.4	28.6	8.7	3.46	<0.09	12.6	64	0.02	0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.20	1.5	7.67	8.64	23.00	0.002	0
	08/09/2020		8.03	41	222	186	140	37.1	22.6	12.6	3.70	0.22	18.0	44	<0.01	<0.01	<0.01	0.01	0.02	<0.45	<0.35	<0.45	<0.03	0.37	7.3	7.69	16.10	1.00	0.006	0
LSW05 A	21/11/2019		7.83	51.5	245	218	201	43.9	26.4	9.7	2.84	0.21	13.9	27	<0.01	0.04	<0.01	<0.01	<0.02	<0.45	<0.01	<0.45	<0.03	0.14	2.7	5.66	15.7	0.80	0.02	4
	05/12/2019		7.55	46.4	245	219	153	47.5	24.4	7.4	5.59	0.18	10.5	57	<0.01	<0.01	<0.01	0.03	<0.02	<0.45	<0.35	<0.45	<0.03	0.05	4.1	6.78	19.2	3.60	<0.001	30
	16/01/2020		7.69	50.6	266	231	174	45.6	28.5	10.5	5.57	0.17	18.2	53	0.01	0.03	<0.01	0.03	<0.02	<0.45	<0.35	<0.45	<0.03	0.13	6.6	6.57	14.7	1.20	0.02	13
	06/02/2020		7.55	35.1	172	147	146	30.5	17.1	9.2	1.70	0.22	13.6	12	0.04	0.21	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.04	7.3	7.53	20.8	1.20	0.002	68
	09/03/2020		7.49	43.0	230	186	163	38.4	21.9	11.8	4.70	0.21	17.7	37	<0.01	0.03	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	0.12	0.51	5.3	6.97	18.2	1.00	<0.001	4
	08/05/2020		7.62	41.2	222	186	127	40.0	20.8	8.6	4.44	<0.09	16.4	53	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	0.64	<0.45	<0.03	0.49	56.3	6.77	14.2	1.60	0.005	30
	19/05/2020		7.75	42.3	244	204	138	40.7	24.9	12.0	3.79	<0.09	13.2	66	<0.01	0.03	0.02	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.28	2.1	6.82	13.4	1.00	0.006	46
	02/06/2020		7.91	43.7	247	201	135	39.8	24.7	11.1	2.52	<0.09	13.6	75	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.67	2.9	7.70	10.0	1.20	0.002	0
	07/07/2020		7.99	45.2	243	194	140	40.1	22.8	10.0	3.55	<0.09	14.9	68	0.03	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.27	13.0	7.51	5.5	5.00	0.05	10
	13/08/2020		7.99	45.1	242	193	153	40.4	22.3	10.3	3.83	0.14	13.6	59	0.08	0.01	0.02	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.17	10.1	7.38	10.2	0.33	<0.001	2
	08/09/2020		8.08	48.4	262	217	188	43.2	26.4	12.7	4.98	0.10	15.1	46	0.03	<0.01	<0.01	0.02	0.02	<0.45	<0.35	<0.45	<0.03	0.21	11.4	7.38	13.6	1.60	0.008	0

Exxaro Leeuwpan																														
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Boron (B)	Hexavalent Chromium (Cr^{6})	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Total Inorganic Nitrogen (mg/l)	Ortho Phosphate as P (mg/l)	Total Phospahte	Turbidity	Dissolved Oxygen (DO)	Dissolved Organic Carbon (DOC)	Oil & Grease	Chlorofyll-a	*Escherichia coli* (*E.coli*)
DWAF Domestic Target Water Quality Range			6.0 - 9.0	70	450	-	-	32	30	100	50	1	100	200	0.1	0.05	0.15	-	0.050	1	6	-	-	-	1	-	5	-	1	0
Surface Water																														
Comparrison Samples																														
WP01 A	19/05/2020		7.60	52.2	307	250	189	44.7	33.5	14.3	7.44	<0.09	12.6	81	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.06	4.6	6.61	19.4	0.60	<0.001	32
	02/06/2020		7.86	52.5	303	251	183	45.8	33.2	14.9	7.14	<0.09	12.6	79	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.71	17.4	7.44	17.0	0.60	0.003	0
	07/07/2020		8.27	56.9	289	258	262	51.6	31.4	11.2	7.02	<0.09	13.6	17	0.03	0.02	<0.01	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.15	10.6	7.74	19.8	6.67	0.01	0
LSW13 A	12/09/2019		7.05	220	1945	1342	39	244.0	178.0	43.1	13.80	0.28	16.4	1426	0.07	0.01	0.06	0.08	<0.02	<0.45	<0.35	<0.45	<0.03	0.61	330.0	6.33	11.00	1.20	0.02	0
WP 02 A	12/09/2019		7.73	49.9	255	227	244	43.8	28.6	16.0	3.83	0.11	10.9	5.6	<0.01	<0.01	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.33	15.10	6.22	9.3	1.20	<0.001	0
	21/11/2019		7.76	43.9	221	187	182	37.8	22.4	13.1	4.09	0.17	9.5	24.7	<0.01	<0.01	<0.01	<0.01	<0.02	<0.45	<0.01	<0.45	<0.03	0.12	8.07	5.48	13.2	0.80	<0.001	0
	05/12/2019		7.21	20	96	72	76	16.1	7.8	1.9	5.68	0.29	4.9	11	0.96	<0.01	1.89	0.02	<0.02	<0.45	<0.35	<0.45	<0.03	0.55	78.0	7.02	12.60	2.00	<0.001	26
	16/01/2020		7.71	41	211	185	190	33.3	24.8	11.2	4.43	0.15	9.1	13	0.52	0.10	0.88	0.02	<0.02	<0.45	<0.35	<0.45	<0.03	0.18	24.2	6.26	11.70	1.10	0.01	12
	06/02/2020		7.95	48	243	215	206	42.9	26.1	11.8	1.55	0.14	3.9	33	<0.01	<0.01	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.07	44.7	7.73	10.90	3.20	0.075	8
	09/03/2020		7.71	46	236	223	222	48.5	24.7	10.8	2.28	0.09	5.2	12	0.01	<0.01	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.13	7.1	6.33	9.32	1.20	0.013	0
	08/05/2020		8.00	54	295	271	233	59.0	30.0	10.1	5.99	<0.09	15.2	33	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	0.39	<0.45	<0.03	0.03	4.7	6.41	19.10	0.80	<0.001	6
	19/05/2020		7.92	55	287	257	235	53.4	30.0	13.0	4.80	<0.09	10.0	34	0.08	<0.01	0.03	<0.01	<0.01	<0.45	<0.35	<0.45	<0.03	0.08	4.2	6.46	17.50	0.80	0.005	2
	02/06/2020		7.80	53	286	256	235	50.9	31.4	12.3	5.29	<0.09	11.1	31	<0.01	<0.01	<0.01	<0.01	<0.01	<0.45	0.74	<0.45	<0.03	0.43	8.7	7.65	13.10	0.80	<0.001	0
	07/07/2020		7.57	54	282	236	218	47.0	28.8	13.5	5.20	<0.09	12.3	41	0.02	0.01	<0.01	<0.01	<0.01	<0.45	0.62	0.62	<0.03	0.17	2.3	7.38	16.30	3.33	0.02	60
	08/09/2020		8.52	47	243	223	228	45.9	26.2	12.6	3.01	0.15	9.5	7	0.01	0.02	<0.01	<0.01	0.02	<0.45	0.39	<0.45	<0.03	0.22	14.3	7.38	12.90	1.40	0.01	0

Table 6: Process Water Sample Results

Exxaro Leeuwpan																															
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Boron (B)	Hexavalent Chromium (Cr^{6})	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Total Inorganic Nitrogen (mg/l)	Ortho Phosphate as P (mg/l)	Total Phosphate	Turbidity	Dissolved Oxygen (DO)	Dissolved Organic Carbon (DOC)	Oil & Grease	Chlorofyl-a	Escherichia coli (E.coli)
WUL Limit			5.0 - 10.0	750	3800	-	-	-	300	500	40	5	500	3200	20	10	10	-	5	10	20	15	10	20	-	-	100	1000	0.15	10
General Authorisation Limits			5.5-9.5	150	-	-	-	-	-	-	-	1	-	-	0.3	0.1	-	-	0.05	6	15	-	10	-	-	-	-	2.5	-	-
Process Water																															
KR01A	15/10/2019		7.88	380	3647	2708	162	692	238	50.2	11.9	<0.09	19.1	2538	0.03	<0.01	<0.01	0.10	<0.02	<0.45	<0.35	<0.45	<0.03	<0.03	9.7	5.92	5.14	2.00	0.004	18
	21/11/2019		7.90	343	3510	2590	122	630	247	46.6	11.1	<0.09	13.8	2488	0.10	0.12	<0.01	0.08	<0.02	<0.45	<0.01	<0.45	<0.03	0.05	12.2	5.28	8.12	0.80	0.047	4
	05/12/2019		7.91	338	3356	2622	113	608	268	50.6	11.7	<0.09	14.5	2335	<0.01	<0.01	<0.01	0.13	<0.02	<0.45	<0.35	<0.45	<0.03	<0.03	14.6	6.81	5.17	2.40	<0.001	20
	16/01/2020		7.91	340	3304	2498	152	598	244	50.4	12.5	<0.09	16.8	2290	0.08	0.15	0.15	0.09	<0.02	<0.45	<0.35	<0.45	<0.03	0.06	21.5	6.22	6.07	1.40	0.02	5
	06/02/2020		7.75	259	2432	1700	51	463	132	41.9	8.2	0.14	12.8	1697	0.24	0.18	0.15	<0.01	<0.02	0.60	9.42	11.00	<0.03	0.05	5.6	7.49	4.68	6.40	<0.001	6
	10/03/2020		7.60	263	2519	1920	73	482	174	36.9	9.7	<0.09	12.6	1738	0.01	0.04	<0.01	<0.01	<0.02	<0.45	4.70	4.83	<0.03	0.17	3.8	6.48	2.71	1.75	<0.001	4
	08/05/2020		7.56	260	2522	1892	100	474	172	39.8	11.7	<0.09	14.1	1733	0.09	0.02	<0.01	<0.01	0.03	<0.45	3.92	3.92	<0.03	0.05	11.1	6.38	9.90	1.40	<0.001	8
	19/05/2020		7.27	251	2402	1816	116	452	167	47.0	12.0	<0.09	12.0	1608	0.03	0.04	<0.01	0.02	<0.01	<0.45	7.58	7.79	<0.03	0.06	3.2	6.34	9.22	1.60	0.006	0
	02/06/2020		7.98	262	2565	1872	119	466	172	46.7	10.9	<0.09	12.8	1755	0.10	0.43	<0.01	0.03	<0.01	<0.45	6.68	6.82	<0.03	0.23	2.3	7.63	6.58	1.40	<0.001	0
	07/07/2020		7.97	269	2514	1845	127	455	172	40.4	11.5	<0.09	12.4	1722	0.35	0.58	<0.01	0.06	0.03	<0.45	5.10	5.22	<0.03	0.15	2.1	7.60	5.04	0.67	0.01	0
	13/08/2020		7.91	257	2560	1915	130	475	177	45.0	12.3	<0.09	12.3	1728	<0.01	0.29	<0.01	<0.01	<0.01	0.77	7.00	7.93	<0.03	0.22	2.0	7.68	6.40	2.50	<0.001	0
	09/09/2020		8.22	275	2627	1867	129	484	160	43.0	12.3	<0.09	15.8	1812	0.02	0.54	<0.01	0.14	0.03	0.71	4.69	5.59	<0.03	0.13	14.7	7.21	7.48	6.00	0.01	18
KR03	15/10/2019	No Stream																													
	21/11/2019	No Stream																													
	05/12/2019	No Stream																													
	16/01/2020	No Stream																													
	06/02/2020	No Stream																													
	09/03/2020	No Stream																													
	08/05/2020	No Stream																													
	19/05/2020	No Stream																													
	02/06/2020	No Stream																													
	07/07/2020	No Stream																													
	13/08/2020	No Stream																													
	07/09/2020	No Stream																													

Exxaro Leeuwpan																														
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Boron (B)	Hexavalent Chromium (Cr^{6})	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Total Inorganic Nitrogen (mg/l)	Ortho Phosphate as P (mg/l)	Total Phosphate	Turbidity	Dissolved Oxygen (DO)	Dissolved Organic Carbon (DOC)	Oil & Grease	Chlorofyl-a	Escherichia coli (E.coli)
WUL Limit			5.0 - 10.0	750	3800	-	-	-	300	500	40	5	500	3200	20	10	10	-	5	10	20	15	10	20	-	-	100	1000	0.15	10
General Authorisation Limits			5.5-9.5	150	-	-	-	-	-	-	-	1	-	-	0.3	0.1	-	-	0.05	6	15	-	10	-	-	-	-	2.5	-	-
Process Water																														
KR04	15/10/2019	Dry																												
	21/11/2019	Dry																												
	05/12/2019	Dry																												
	16/01/2020	Dry																												
	06/02/2020	Dry																												
	09/03/2020	Dry																												
	08/05/2020	Dry																												
	19/05/2020	Dry																												
	02/06/2020	Dry																												
	07/07/2020	Dry																												
	13/08/2020	Dry																												
	07/09/2020	Dry																												
LSW09	15/10/2019		7.38	319	3044	2142	98	505	214	58.1	15.9	<0.09	17.7	2128	0.98	<0.01	0.04	0.17	<0.02	<0.45	9.05	10.5	<0.03	0.27	284.00	5.48	6.24	1.60	0.006	100
	21/11/2019		8.48	88	522	396	35	104	33	5.2	2.4	<0.09	3.5	345	0.17	0.03	0.45	0.05	<0.02	<0.45	0.09	1.51	<0.03	0.07	53.60	5.84	16.35	0.80	<0.001	8
	05/12/2019		7.63	144	1156	880	40	237	70	16.9	5.5	0.15	10.7	778	<0.01	<0.01	0.05	0.09	<0.02	0.51	2.86	3.54	<0.03	0.13	36.40	7.10	12.80	3.20	<0.001	2
	16/01/2020		7.89	238	2129	1545	74	363	155	35.6	11.8	0.16	14.1	1482	0.58	0.03	0.21	0.10	<0.02	0.51	4.43	4.85	<0.03	0.10	83.00	5.94	8.96	1.00	0.01	1
	06/02/2020		6.93	221	1919	1358	33	336	126	40.3	8.4	0.20	16.3	1348	0.02	0.09	<0.01	0.07	<0.02	0.53	5.25	5.82	<0.03	0.06	139.00	7.38	43.50	3.20	1.339	110
	10/03/2020		7.73	229	2011	1432	71	341	141	41.4	12.3	<0.09	14.5	1373	0.02	0.11	<0.01	<0.01	<0.02	0.57	9.82	10.68	<0.03	0.27	14.30	6.39	3.88	1.50	<0.001	8
	08/05/2020		7.85	208	1866	1295	70	309	127	35.8	9.9	<0.09	13.7	1287	0.04	0.06	<0.01	<0.01	0.02	0.47	8.98	9.93	<0.03	0.48	9.73	6.28	8.24	1.20	<0.001	38
	19/05/2020		7.86	226	2002	1402	76	337	136	47.7	13.9	<0.09	14.8	1366	<0.01	0.13	0.04	0.08	<0.01	1.15	8.66	9.81	<0.03	0.13	7.94	6.25	7.82	1.20	<0.001	42
	02/06/2020		7.76	172	1538	1085	77	268	101	33.4	8.9	<0.09	14.7	1036	0.25	0.05	<0.01	0.03	<0.01	0.61	6.53	7.31	<0.03	0.55	4.59	7.71	7.84	0.80	<0.001	0
	07/07/2020		8.06	261	2396	1719	89	413	167	42.1	11.8	<0.09	14.2	1663	0.35	0.20	<0.01	0.08	0.03	0.52	6.62	7.29	<0.03	0.17	7.33	7.57	5.44	1.17	0.02	0
	13/08/2020		7.77	289	2783	1958	76	441	208	49.7	14.5	<0.09	15.9	1956	<0.01	0.04	<0.01	<0.01	<0.01	<0.45	11.60	11.7	<0.03	0.15	26.30	7.53	5.66	3.80	0.007	10
	09/09/2020		7.67	269	2536	1815	89	420	186	45.2	13.5	<0.09	16.7	1763	0.02	0.22	<0.01	0.19	0.03	1.46	7.89	9.71	<0.03	0.28	15.00	7.54	6.72	1.80	0.01	4

Exxaro Leeuwpan																														
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Boron (B)	Hexavalent Chromium (Cr^{6})	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Total Inorganic Nitrogen (mg/l)	Ortho Phosphate as P (mg/l)	Total Phosphate	Turbidity	Dissolved Oxygen (DO)	Dissolved Organic Carbon (DOC)	Oil & Grease	Chlorofyll-a	Escherichia coli (E.coli)
WUL Limit			5.0 - 10.0	750	3800	-	-	-	300	500	40	5	500	3200	20	10	10	-	5	10	20	15	10	20	-	-	100	1000	0.15	10
General Authorisation Limits			5.5-9.5	150	-	-	-	-	-	-	-	1	-	-	0.3	0.1	-	-	0.05	6	15	-	10	-	-	-	-	2.5	-	-
Process Water																														
ODN_PIT	15/10/2019		7.59	307	2876	2025	62.8	491	194	52.5	14.0	<0.09	18.0	2018	<0.01	0.16	<0.01	0.09	<0.02	0.61	10.1	12.3	<0.03	<0.03	20.60	5.58	2.39	2.40	0.01	0
	21/11/2019		7.91	297	2796	2037	63.6	509	186	43.5	13.1	<0.09	14.0	1950	0.08	0.16	0.04	0.10	<0.02	0.78	0.9	10.22	<0.03	0.06	17.90	5.61	3.11	4.00	<0.001	2
	05/12/2019		7.70	283	2683	1968	54.0	471	192	50.4	14.0	0.13	18.7	1860	<0.01	0.34	<0.01	0.08	<0.02	0.65	9.1	10.5	<0.03	<0.03	13.20	7.07	2.99	2.40	0.002	0
	16/01/2020		7.82	296	2758	2006	64.6	480	196	49.5	14.1	0.15	17.2	1915	0.08	0.21	0.04	0.09	0.02	0.76	9.4	10.4	<0.03	0.10	18.60	6.17	3.89	1.33	0.03	0
	06/02/2020		7.57	259	2407	1770	50.0	430	169	39.1	7.2	0.15	13.5	1672	0.05	0.17	<0.01	<0.01	<0.02	0.60	9.5	11.1	<0.03	0.06	28.60	7.11	4.68	3.20	0.002	18
	09/03/2020		7.30	255	2412	1747	49.0	429	164	42.5	12.5	<0.09	13.9	1667	<0.01	0.18	<0.01	<0.01	<0.02	0.49	11.2	12.68	<0.03	0.13	3.89	6.54	2.41	0.80	<0.001	6
	08/05/2020		7.75	253	2417	1680	49.8	404	163	43.4	12.6	<0.09	15.5	1694	0.02	0.18	<0.01	0.04	0.01	1.07	11.0	13.3	<0.03	0.25	7.26	6.44	7.16	0.60	0.008	0
	19/05/2020		7.23	256	2364	1743	50.6	431	162	45.3	14.6	<0.09	14.0	1612	0.02	0.13	<0.01	0.04	0.01	1.36	11.5	13.5	<0.03	0.12	9.45	6.88	7.04	1.80	<0.001	8
	02/06/2020		7.68	257	2460	1756	53.6	436	162	49.9	13.5	<0.09	14.3	1697	0.15	0.16	<0.01	0.05	<0.01	1.30	11.9	13.8	<0.03	0.34	18.70	7.52	5.90	1.40	<0.001	2
	07/07/2020		7.82	257	2390	1662	61.8	395	164	42.2	12.1	<0.09	14.1	1678	0.69	0.26	<0.01	0.08	0.07	0.95	10.2	11.6	<0.03	0.16	3.63	7.64	2.77	5.00	0.01	0
	13/08/2020		7.66	259	2399	1717	68.2	394	178	41.7	14.3	<0.09	14.1	1653	<0.01	0.43	<0.01	<0.01	<0.01	1.80	13.6	15.8	<0.03	0.13	5.53	7.21	4.42	0.50	0.001	0
	09/09/2020		7.88	264	2439	1676	69.6	409	159	44.7	14.0	<0.09	16.1	1706	0.02	0.27	<0.01	0.17	0.03	1.87	10.2	12.6	<0.03	0.08	17.90	7.54	5.78	0.60	0.003	0
OG_PIT	15/10/2019	Rehabilitated																												
	21/11/2019	Rehabilitated																												
	05/12/2019	Rehabilitated																												
	16/01/2020	Rehabilitated																												
	06/02/2020	Rehabilitated																												
	09/03/2020	Rehabilitated																												
	08/05/2020	Rehabilitated																												
	19/05/2020	Rehabilitated																												
	02/06/2020	Rehabilitated																												
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	13/08/2020	Rehabilitated																												
	09/09/2020	Rehabilitated																												

Exxaro Leeuwpan																														
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Boron (B)	Hexavalent Chromium (Cr^{6})	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Total Inorganic Nitrogen (mg/l)	Ortho Phosphate as P (mg/l)	Total Phosphate	Turbidity	Dissolved Oxygen (DO)	Dissolved Organic Carbon (DOC)	Oil & Grease	Chlorofyl-a	Escherichia coli (E.coli)
WUL Limit			5.0 - 10.0	750	3800	-	-	-	300	500	40	5	500	3200	20	10	10	-	5	10	20	15	10	20	-	-	100	1000	0.15	10
General Authorisation Limits			5.5-9.5	150	-	-	-	-	-	-	-	1	-	-	0.3	0.1	-	-	0.05	6	15	-	10	-	-	-	-	2.5	-	-
Process Water																														
OH_PIT	15/10/2019	Rehabilitated																												
	21/11/2019	Rehabilitated																												
	05/12/2019	Rehabilitated																												
	16/01/2020	Rehabilitated																												
	06/02/2020	Rehabilitated																												
	09/03/2020	Rehabilitated																												
	08/05/2020	Rehabilitated																												
	19/05/2020	Rehabilitated																												
	02/06/2020	Rehabilitated																												
	07/07/2020	Rehabilitated																												
	13/08/2020	Rehabilitated																												
	09/09/2020	Rehabilitated																												
OJ_PIT	15/10/2019	Rehabilitated																												
	21/11/2019	Rehabilitated																												
	05/12/2019	Rehabilitated																												
	16/01/2020	Rehabilitated																												
	06/02/2020	Rehabilitated																												
	09/03/2020	Rehabilitated																												
	08/05/2020	Rehabilitated																												
	19/05/2020	Rehabilitated																												
	02/06/2020	Rehabilitated																												
	07/07/2020	Rehabilitated																												
	13/08/2020	Rehabilitated																												
	09/09/2020	Rehabilitated																												

Exxaro Leeuwpan																														
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Boron (B)	Hexavalent Chromium (Cr^{6})	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Total Inorganic Nitrogen (mg/l)	Ortho Phosphate as P (mg/l)	Total Phosphate	Turbidity	Dissolved Oxygen (DO)	Dissolved Organic Carbon (DOC)	Oil & Grease	Chlorofyl-a	Escherichia coli (E.coli)
WUL Limit			5.0 - 10.0	750	3800	-	-	-	300	500	40	5	500	3200	20	10	10	-	5	10	20	15	10	20	-	-	100	1000	0.15	10
General Authorisation Limits			5.5-9.5	150	-	-	-	-	-	-	-	1	-	-	0.3	0.1	-	-	0.05	6	15	-	10	-	-	-	-	2.5	-	-
Process Water																														
OM_PIT	15/10/2019	Rehabilitated																												
	21/11/2019	Rehabilitated																												
	05/12/2019	Rehabilitated																												
	16/01/2020	Rehabilitated																												
	06/02/2020	Rehabilitated																												
	09/03/2020	Rehabilitated																												
	08/05/2020	Rehabilitated																												
	19/05/2020	Rehabilitated																												
	02/06/2020	Rehabilitated																												
	07/07/2020	Rehabilitated																												
	13/08/2020	Rehabilitated																												
	09/09/2020	Rehabilitated																												
OWM_PIT	15/10/2019		8.45	128.0	800	524	85	96.4	68.7	52.6	2.38	0.53	4.28	524	<0.01	<0.01	<0.01	0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.09	42.00	5.62	9.86	0.80	<0.001	0
	21/11/2019		8.11	77.1	472	324	18	64.4	39.7	13.4	2.74	0.21	2.40	336	0.24	0.05	0.37	0.01	<0.02	<0.45	<0.01	<0.45	<0.03	0.05	35.10	5.71	6.00	3.60	<0.001	8
	05/12/2019		8.17	84.1	596	417	39	113.0	32.9	22.7	3.05	0.28	11.20	374	<0.01	<0.01	<0.01	0.08	<0.02	<0.45	3.49	3.53	<0.03	<0.03	37.20	7.00	5.17	2.80	0.004	0
	16/01/2020		7.99	95.7	622	426	67	82.4	53.4	32.8	3.06	0.32	4.92	396	0.13	0.05	0.20	0.03	<0.02	<0.45	1.93	1.98	<0.03	0.11	22.60	6.16	7.93	1.20	0.01	0
	06/02/2020		7.64	29.0	159	124	32	27.4	13.5	1.6	1.51	0.20	1.61	94	<0.01	<0.01	<0.01	<0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.04	34.60	7.24	5.04	1.20	<0.001	0
	09/03/2020		7.84	29.7	154	121	24	26.1	13.5	1.6	1.71	0.24	1.73	95	0.06	<0.01	0.09	<0.01	<0.02	<0.45	<0.35	<0.45	<0.03	0.19	21.40	6.55	4.53	1.75	<0.001	14
	08/05/2020		7.23	23.9	151	108	29	23.8	11.8	3.2	3.25	0.10	5.80	85	0.02	0.07	<0.01	<0.01	0.02	<0.45	<0.35	<0.45	<0.03	0.98	1000.00	6.79	20.40	2.00	0.03	1500
	19/05/2020	Dry																												
	02/06/2020	Dry																												
	07/07/2020	Dry																												
	13/08/2020	Dry																												
	09/09/2020	Dry																												

Exxaro Leeuwpan																														
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Boron (B)	Hexavalent Chromium (Cr^{6})	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Total Inorganic Nitrogen (mg/l)	Ortho Phosphate as P (mg/l)	Total Phosphate	Turbidity	Dissolved Oxygen (DO)	Dissolved Organic Carbon (DOC)	Oil & Grease	Chlorofyl-a	Escherichia coli (E.coli)
WUL Limit			5.0 - 10.0	750	3800	-	-	-	300	500	40	5	500	3200	20	10	10	-	5	10	20	15	10	20	-	-	100	1000	0.15	10
General Authorisation Limits			5.5-9.5	150	-	-	-	-	-	-	-	1	-	-	0.3	0.1	-	-	0.05	6	15	-	10	-	-	-	-	2.5	-	-
Process Water																														
WLV-PIT	15/10/2019	Rehabilitated																												
	21/11/2019	Rehabilitated																												
	05/12/2019	Rehabilitated																												
	16/01/2020	Rehabilitated																												
	06/02/2020	Rehabilitated																												
	09/03/2020	Rehabilitated																												
	08/05/2020	Rehabilitated																												
	19/05/2020	Rehabilitated																												
	02/06/2020	Rehabilitated																												
	07/07/2020	Rehabilitated																												
	13/08/2020	Rehabilitated																												
	09/09/2020	Rehabilitated																												
WP04	15/10/2019		7.47	559.0	5073	3699	64	624.0	520.0	179.0	33.50	<0.09	56.70	3621	<0.01	<0.01	<0.01	0.12	<0.02	<0.45	<0.35	<0.45	<0.03	<0.03	17.90	5.89	30.70	4.00	<0.001	0
	21/11/2019	No Access																												
	05/12/2019		7.64	447.0	4633	3339	52	623.0	433.0	156.0	28.10	0.13	46.50	3314	0.24	0.26	<0.01	0.17	<0.02	<0.45	<0.35	<0.45	<0.03	0.03	108.00	6.78	26.40	0.80	<0.001	0
	16/01/2020		7.56	503.0	4908	3550	60	630.0	480.0	165.0	30.80	0.14	52.90	3512	0.24	0.26	<0.01	0.15	<0.02	<0.45	<0.35	<0.45	<0.03	0.03	70.20	6.28	29.10	1.40	<0.001	0
	06/02/2020	No Access																												
	10/03/2020		8.00	231.0	2162	1608	231	405.0	145.0	37.2	10.80	<0.09	15.90	1363	0.03	0.13	<0.01	<0.01	<0.02	0.52	10.10	10.91	<0.03	0.13	14.20	6.42	3.66	0.70	<0.001	12
	08/05/2020		7.80	254.0	2395	1737	50	425.0	164.0	43.2	11.40	<0.09	14.30	1654	0.04	0.20	<0.01	<0.01	0.03	0.97	10.80	13	<0.03	0.10	9.03	6.68	6.58	1.60	0.01	0
	19/05/2020		8.15	255.0	2344	1698	54	411.0	163.0	46.0	13.50	<0.09	13.80	1609	0.02	0.15	<0.01	0.04	0.01	1.32	11.40	13.4	<0.03	0.01	8.98	6.71	6.64	0.60	<0.001	8
	02/06/2020		7.73	255.0	2393	1708	55	412.0	165.0	48.2	14.00	<0.09	14.30	1650	0.10	0.20	<0.01	0.06	<0.01	1.32	12.20	14.1	<0.03	0.36	5.35	7.65	5.72	0.80	0.006	0
	07/07/2020		7.93	257.0	2412	1701	61	406.0	167.0	43.0	12.50	<0.09	13.50	1686	0.69	0.27	<0.01	0.07	0.07	0.86	10.20	11.51	<0.03	0.19	5.08	7.49	3.20	6.67	0.02	0
	13/08/2020		7.69	259.0	2533	1815	67	417.0	188.0	51.2	14.70	<0.09	13.80	1746	<0.01	0.09	<0.01	<0.01	<0.01	1.88	13.60	15.9	<0.03	0.10	3.89	7.55	4.32	5.00	0.002	0
	09/09/2020		7.42	263.0	2648	1831	69	420.0	190.0	44.7	14.00	0.42	15.10	1836	0.02	0.26	<0.01	0.17	0.03	17.00	14.30	31.8	<0.03	0.15	9.35	7.68	5.54	0.67	<0.001	6

Exxaro Leeuwpan																													
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Boron (B)	Hexavalent Chromium (Cr^{6})	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Total Inorganic Nitrogen (mg/l)	Ortho Phosphate as P (mg/l)	Total Phosphate	Turbidity	Dissolved Oxygen (DO)	Dissolved Organic Carbon (DOC)	Oil & Grease	Chlorofyll-a	Escherichia coli (E.coli)
WUL Limit			5.0 - 10.0	750	3800	-	-	-	300	500	40	5	500	3200	20	10	10	-	5	10	20	15	10	20	-	-	100	1000	0.15	10
General Authorisation Limits			5.5-9.5	150	-	-	-	-	-	-	-	1	-	-	0.3	0.1	-	-	0.05	6	15	-	10	-	-	-	-	2.5	-	-
Process Water																													
Comparrison Samples																													
OWM_PIT A	18/07/2019		8.93	59.4	381	210	116	42.4	25.4	48.7	1.68	1.38	1.39	190	<0.01	<0.01	0.05	0.04	<0.02	<0.45	<0.35	<0.45	<0.03	0.02	2.20	7.23	7.20	2.00	0.007	0
OWP - Pit B Surface	15/10/2019		8.26	128.0	779	501	97	92.7	65.5	53.3	2.14	0.52	3.90	503	0.03	<0.01	<0.01	0.04	<0.02	<0.45	<0.35	<0.45	<0.03	0.42	34.30	5.44	12.00	1.20	0.001	4
LSW09 A	15/10/2019		7.64	320.0	3056	2161	103	519.0	210.0	46.2	13.00	<0.09	18.20	2144	<0.01	<0.01	<0.01	0.11	<0.02	1.16	8.54	10.9	<0.03	0.03	73.60	5.66	6.54	1.60	0.006	0
KR01B	20/08/2019		7.92	325	2897	2134	184	490	221	45.1	15.3	<0.09	15.5	1999	0.02	0.02	<0.01	0.08	<0.02	<0.45	<0.35	<0.45	<0.03	0.03	6.4	6.48	6.27	3.00	0.029	12
	15/10/2019		7.91	381	3708	2753	164	649	275	56.7	15.6	<0.09	19.2	2594	0.03	<0.01	<0.01	0.10	<0.02	<0.45	<0.35	<0.45	<0.03	<0.03	18.7	5.21	5.30	2.40	<0.001	12
WP04 A	07/07/2020		7.93	257	2343	1682	63	400	166	42.5	12.3	<0.09	12.9	1624	0.69	0.27	<0.01	0.07	0.07	1.14	10.20	11.80	<0.03	0.34	5.0	7.62	2.85	2.22	0.01	0

Table 7: Effluent Water Sample Results

Exxaro - Leeuwpan										
Sample Number	Date	Comment	Suspended Solids (SS) mg/l	Ammonia mg/l	Nitrate (N) mg/l	Ortho-phosphate mg/l	Total Phosphate mg/l	Chemical Oxygen Demand (total)	Escherichia coli (E.coli)	Faecal Coliforms
Exxaro - Leeuwpan Wastewater WUL Limit			-	10	20	10	20	-	10	-
General Authorisation Limits			25	6	15	10	-	75	-	1000
Treated Sewage										
LWP_SP_P	15/10/2019		28.00	75.60	<0.35	3.50	4.23	167.00	0	130
	21/11/2019		62.80	119.00	<0.35	4.70	5.82	251.00	1500	1500
	05/12/2019		37.20	133.00	<0.35	3.95	7.31	197.00	1500	1500
	16/01/2020		56.80	72.40	<0.35	4.34	5.34	164.00	1500	1500
	06/02/2020		96.80	94.10	6.05	3.13	4.60	258.00	0	0
	10/03/2020		6.40	93.90	3.18	3.73	5.02	123.00	0	0
	08/05/2020		30.80	55.00	1.71	3.39	4.55	108.00	0	40
	18/05/2020		132.00	50.10	1.64	4.48	5.37	238.00	130	1500
	02/06/2020		275.00	36.30	3.06	3.55	4.75	494.00	0	0
	07/07/2020		76.00	78.00	7.34	2.59	5.48	202.00	0	0
	13/08/2020		164.00	24.90	7.70	2.70	4.80	278.00	0	10
	07/09/2020	Not Active								

Exxaro - Leeuwpan										
Sample Number	Date	Comment	Suspended Solids (SS) mg/l	Ammonia mg/l	Nitrate (N) mg/l	Ortho-phosphate mg/l	Total Phosphate mg/l	Chemical Oxygen Demand (total)	Escherichia coli (E.coli)	Faecal Coliforms
Exxaro - Leeuwpan Wastewater WUL Limit			-	10	20	10	20	-	10	-
General Authorisation Limits			25	6	15	10	-	75	-	1000
Treated Sewage										
LWP_SP_W	15/10/2019	Maintenance								
	21/11/2019	Maintenance								
	05/12/2019	Maintenance								
	16/01/2020	Maintenance								
	09/03/2020	Maintenance								
	08/05/2020	Maintenance								
	18/05/2020	Maintenance								
	02/06/2020	Maintenance								
	07/07/2020	Maintenance								
	13/08/2020	Maintenance								
	08/09/2020	No Access								

Table 8: Potable Water Sample Results

Exxaro - Leeuwpan																								
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids (mg/l)	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO 4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Ortho Phosphate as P (mg/l)	Turbidity (NTU)	Dissolved Oxygen (DO mg/l)	Sodium Absorption Ratio (indicative)	Escherichia coli (E.coli count per 100ml)	Heterotrophic plate count
SANS 241:2015 Strd. Lim. (Operational)			5.0 - 9.7	≤ 170	≤ 1200	-	-	-		≤ 200	-	≤ 1.5	≤ 300	≤ 500	≤ 2	≤ 0.4	≤ 0.3	≤ 1.5	≤ 12	-	≤ 5	-	-	0	≤1000
Potable Water																								
LDWST	15/10/2019		7.96	60.1	344	217	153	46.5	24.6	34.8	5.05	0.16	52.5	81.3	<0.01	<0.01	<0.01	<0.45	1.61	<0.03	1.10	5.83	1.02	0	1520
	21/11/2019	No Access																						
	05/12/2019		7.85	59.1	327	216	147	44.7	25.3	31.9	4.33	0.19	47.9	76.7	0.03	<0.01	<0.01	<0.45	1.76	<0.03	2.37	7.12	0.94	128	3000
	16/01/2020		7.92	56.8	334	233	153	51.8	25.1	29.2	4.60	0.16	42.9	80.5	0.04	<0.01	<0.01	<0.45	1.7	<0.03	1.19	6.90	0.83	0	2900
	06/02/2020		7.67	58.0	308	232	146	49.5	26.4	21.7	1.94	0.15	41.2	72.4	<0.01	<0.01	<0.01	<0.45	1.67	<0.03	1.62	7.38	0.62	0	870
	10/03/2020		7.97	59.2	327	227	144	49.5	25.1	30.9	4.49	0.13	43.9	78.7	<0.01	<0.01	<0.01	<0.45	1.78	0.03	1.76	6.15	0.89	2	3000
	08/05/2020		7.73	59.0	336	226	149	51.1	24.0	31.3	4.27	<0.09	45	81.7	0.10	0.03	0.09	<0.45	2.02	<0.03	10.50	6.20	0.90	20	3000
	18/05/2020		7.83	60.2	342	234	149	48.9	27.1	33.2	4.89	<0.09	44.4	84.0	0.02	0.03	<0.01	<0.45	2.13	<0.03	3.19	6.29	0.94	0	740
	02/06/2020	No Water																						
	07/07/2020		7.74	60.2	322	208	154	45.7	22.9	31.4	4.63	<0.09	47.2	69.0	0.01	0.04	<0.01	<0.45	1.8	<0.03	2.35	6.62	0.94	0	370
	13/08/2020		7.59	57.6	321	201	155	40.7	24.2	36.1	5.10	<0.09	40.9	75.4	<0.01	0.03	<0.01	<0.45	1.3	<0.03	1.65	7.69	1.10	0	3000
	09/09/2020		8.00	58.4	331	206	148	41.4	24.8	37.2	4.69	0.24	51.9	74.6	<0.01	0.02	<0.01	<0.45	1.57	<0.03	2.09	7.64	1.12	0	3000
LLBDW	15/10/2019		8.04	51.9	267	196	182	41.8	22.2	24.0	2.92	0.1	31.3	35.5	0.02	<0.01	<0.01	<0.45	<0.35	0.04	4.46	5.21	0.74	0	3000
	20/11/2019		8.14	50.4	261	191	176	39.4	22.6	23.3	2.87	0.1	23.2	43.0	0.39	0.03	<0.01	<0.45	<0.35	0.11	5.90	5.33	0.73	0	3000
	05/12/2019		8.08	50.7	270	208	178	38.2	27.3	21.3	3.23	0.17	25.3	47.5	<0.01	0.04	<0.01	<0.45	<0.35	0.04	7.45	7.06	0.64	0	3000
	16/01/2020		7.85	52.1	279	209	180	42.8	24.8	24.8	3.59	0.16	29.3	44.5	0.23	0.02	0.01	<0.45	<0.35	0.07	6.44	6.50	0.74	0	2800
	06/02/2020		7.89	49.3	288	207	168	40.9	25.4	29.4	2.55	0.16	24.4	63.7	0.15	<0.01	<0.01	<0.45	<0.35	<0.03	27.70	7.13	0.89	0	3000
	09/03/2020		7.81	49.3	255	194	167	34.2	26.4	23.4	3.54	0.13	24.4	42.4	0.14	0.01	<0.01	<0.45	<0.35	0.04	3.63	6.28	0.73	0	3000
	08/05/2020		7.97	48.1	262	198	173	36.8	25.7	22.7	3.08	<0.09	25.1	44.5	<0.01	0.02	<0.01	<0.45	<0.35	<0.03	8.20	6.10	0.70	0	3000
	18/05/2020		7.96	54.2	291	218	173	40.0	28.6	28.0	4.24	<0.09	34.6	51.2	0.30	0.05	<0.01	<0.45	<0.35	<0.03	4.06	6.22	0.82	0	3000
	02/06/2020		7.82	50.4	263	202	185	37.9	26.1	23.1	3.31	<0.09	20	41.1	0.19	0.03	<0.01	<0.45	<0.35	<0.03	3.32	6.10	0.70	0	3000
	07/07/2020		7.89	50.6	264	198	186	38.4	24.7	21.2	3.31	<0.09	25	39.7	<0.01	0.02	<0.01	<0.45	<0.35	<0.03	19.30	7.17	0.65	16	380
	13/08/2020		7.74	271.0	2807	1993	119	495.0	184.0	47.4	14.60	0.21	15.8	1828.0	<0.01	0.02	<0.01	<0.45	33.8	<0.03	12.40	7.21	0.46	0	3000
	09/09/2020		7.75	246.0	2242	1567	96	377.0	152.0	40.9	11.20	<0.09	20.1	1562.0	0.16	0.28	<0.01	<0.45	4.47	<0.03	8.83	7.77	0.45	34	3000

Exxaro - Leeuwpan																								
Sample Number	Date	Comment	Arsenic as As (mg/l)	Boron as B (mg/l)	Barium as Ba (mg/l)	Cadmium as Cd (mg/l)	Cobalt as Co (mg/l)	Chromium as Cr (mg/l)	Copper as Cu (mg/l)	Molybdenum as Mo (mg/l)	Nickel as Ni (mg/l)	Lead as Pb (mg/l)	Selenium as Se (mg/l)	Silicon as Si (mg/l)	Strontium as Sr (mg/l)	Titanium as Ti (mg/l)	Vanadium as V (mg/l)	Zinc as Zn (mg/l)	Mercury as Hg (mg/l)	Lanthanum as La (mg/l)	Lithium as Li (mg/l)	Antimony as Sb (mg/l)	Tin as Sn (mg/l)	Thorium as Th (mg/l)	Thallium as Tl (mg/l)
SANS 241:2015 Strd. Lim. (Operational)			≤ 0.010	≤ 2.400	≤ 0.700	≤ 0.003	-	≤ 0.050	≤ 2	-	≤ 0.070	≤ 0.010	≤ 0.040	-	-	-	-	≤ 5	≤ 0.006	-	-	≤ 0.020	-	-	-
Potable Water			Potable Water																					
LDWST	15/10/2019		<0.005	0.06	0.03	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.04	9.33	0.34	<0.01	0.01	<0.01	<0.003	<0.01	0.06	<0.01	0.35	<0.01	0.07
	21/11/2019	No Access																						
	05/12/2019		<0.005	0.07	0.04	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	11.10	0.51	<0.01	<0.01	<0.01	<0.003	<0.01	0.08	<0.01	0.04	<0.01	0.09
	16/01/2020		<0.05	0.05	0.03	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	12.60	0.38	<0.01	0.40	0.12	<0.03	<0.01	0.06	<0.01	0.04	0.06	0.08
	06/02/2020		<0.005	0.01	0.08	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	6.70	0.11	<0.01	<0.01	0.04	<0.003	<0.01	0.02	<0.01	0.26	0.01	0.01
	10/03/2020		<0.005	<0.01	0.04	0.01	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	10.80	0.32	<0.01	<0.01	<0.01	<0.003	<0.01	0.05	0.18	0.05	<0.01	0.08
	08/05/2020		<0.005	<0.01	0.04	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	12.10	0.39	<0.01	<0.01	<0.01	<0.003	<0.01	0.06	<0.01	<0.01	<0.01	0.06
	18/05/2020		<0.005	0.04	0.04	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	11.10	0.36	<0.01	<0.01	<0.01	<0.003	<0.01	0.06	0.01	<0.01	<0.01	0.01
	02/06/2020	No Water																						
	07/07/2020		<0.005	0.05	0.07	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	9.06	0.44	<0.01	<0.01	0.01	<0.003	<0.01	0.08	<0.01	<0.01	<0.01	<0.01
	13/08/2020		<0.005	<0.01	0.06	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	6.40	0.44	<0.01	<0.01	0.01	<0.003	<0.01	0.07	<0.01	<0.01	<0.01	<0.01
	09/09/2020		<0.005	<0.01	0.06	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	9.77	0.46	<0.01	<0.01	0.02	<0.003	<0.01	0.09	<0.01	<0.01	<0.01	<0.01
LLBDW	15/10/2019		<0.005	0.06	0.09	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.04	7.11	0.07	<0.01	0.01	0.04	<0.003	<0.01	0.02	<0.01	0.38	<0.01	0.03
	20/11/2019		<0.005	<0.01	0.08	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	15.60	0.16	<0.01	<0.01	0.03	<0.003	<0.01	0.02	<0.01	0.06	0.03	<0.01
	05/12/2019		<0.005	0.05	0.08	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	7.63	0.18	<0.01	<0.01	0.01	<0.003	<0.01	0.02	<0.01	0.04	<0.01	0.09
	16/01/2020		<0.05	0.05	0.08	<0.02	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	0.02	8.88	0.13	<0.01	0.21	0.04	<0.03	<0.01	0.02	0.01	0.14	0.05	0.07
	06/02/2020		<0.005	0.01	0.03	<0.002	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	11.40	0.33	<0.01	<0.01	0.13	<0.003	<0.01	0.06	<0.01	0.22	0.02	0.01
	09/03/2020		<0.005	<0.01	0.08	0.01	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	6.79	0.10	<0.01	<0.01	0.03	<0.003	<0.01	0.02	0.18	0.06	<0.01	0.09
	08/05/2020		<0.005	<0.01	0.07	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	7.14	0.12	<0.01	<0.01	0.03	<0.003	<0.01	0.02	0.01	<0.01	<0.01	0.04
	18/05/2020		<0.005	0.04	0.09	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	7.24	0.12	<0.01	<0.01	<0.01	<0.003	<0.01	0.02	0.01	<0.01	<0.01	<0.01
	02/06/2020		<0.005	0.02	0.09	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	7.08	0.13	<0.01	<0.01	<0.01	<0.003	<0.01	0.02	<0.01	<0.01	<0.01	<0.01
	07/07/2020		<0.005	0.04	0.08	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	6.30	0.15	<0.01	<0.01	0.02	<0.003	<0.01	0.02	<0.01	<0.01	<0.01	<0.01
	13/08/2020		<0.005	<0.01	0.06	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	1.80	2.49	<0.01	<0.01	0.78	<0.003	<0.01	0.09	<0.01	<0.01	<0.01	<0.01
	09/09/2020		<0.005	<0.01	0.08	<0.002	<0.01	<0.01	<0.01	0.06	<0.01	<0.01	<0.01	6.38	2.24	<0.01	<0.01	0.28	<0.003	<0.01	0.10	<0.01	<0.01	<0.01	<0.01

Exxaro - Leeuwpan																								
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids (mg/l)	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO 4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Ortho Phosphate as P (mg/l)	Turbidity (NTU)	Dissolved Oxygen (DO mg/l)	Sodium Absorption Ratio (indicative)	Escherichia coli (E.coli count per 100ml)	Heterotrophic plate count
SANS 241:2015 Strd. Lim. (Operational)			5.0 - 9.7	≤ 170	≤ 1200	-	-	-		≤ 200	-	≤ 1.5	≤ 300	≤ 500	≤ 2	≤ 0.4	≤ 0.3	≤ 1.5	≤ 12	-	≤ 5	-	-	0	≤1000
Potable Water																								
LWDL	15/10/2019	Dry																						
	21/11/2019		8.02	59.4	319	229	148	53.5	23.1	27.8	3.93	0.09	42.7	72.7	0.02	<0.01	<0.01	<0.45	1.47	<0.03	1.60	5.76	0.73	0	3000
	05/12/2019		7.97	59.4	328	215	147	44.5	25.2	33.2	4.48	0.24	49.7	74.9	0.05	<0.01	<0.01	<0.45	1.68	<0.03	1.66	7.12	0.98	0	2400
	16/01/2020		7.92	56.9	334	232	152	51.6	25.0	29.1	4.60	0.16	43.6	80.3	0.04	<0.01	<0.01	<0.45	1.74	<0.03	1.02	6.88	0.83	0	2700
	06/02/2020		7.93	58.1	316	225	152	49.0	24.9	29.4	2.53	0.18	40.8	70.2	<0.01	0.03	<0.01	<0.45	1.79	<0.03	4.43	7.54	0.85	0	2040
	09/03/2020		7.92	58.6	325	219	155	46.8	24.8	30.8	4.60	0.15	43.9	72.6	0.03	<0.01	<0.01	<0.45	1.79	<0.03	0.92	6.34	0.90	0	3000
	08/05/2020		8.01	58.6	333	225	152	50.7	23.9	30.9	4.14	<0.09	44.1	78.3	0.02	<0.01	<0.01	<0.45	2.08	<0.03	1.34	6.41	0.89	0	1920
	18/05/2020		8.01	63.0	347	234	154	49.2	27.1	37.4	4.89	<0.09	44.8	82.5	<0.01	<0.01	<0.01	<0.45	1.93	<0.03	0.48	6.56	1.06	0	168
	02/06/2020		7.96	59.4	329	123	150	44.6	24.8	33.4	4.40	<0.09	44.1	79.7	0.03	<0.01	<0.01	<0.45	1.73	<0.03	0.89	6.39	0.99	0	3000
	07/07/2020		7.93	57.2	308	200	151	42.7	22.6	30.4	4.51	<0.09	43.2	65.6	0.01	<0.01	<0.01	<0.45	1.79	<0.03	0.56	7.40	0.93	14	330
	13/08/2020		7.64	264.0	2575	1881	86	443.0	188.0	52.2	15.70	<0.09	14	1771.0	<0.01	<0.01	<0.01	<0.45	8.9	<0.03	15.00	7.44	0.52	0	2200
	09/09/2020		7.86	266.0	2489	1720	82	415.0	166.0	44.9	13.50	<0.09	15.7	1745.0	0.02	0.15	<0.01	<0.45	8.92	<0.03	3.20	7.21	0.47	0	1640
PIET-SCHUTTE	15/10/2019	No Water																						
	21/11/2019	No Water																						
	05/12/2019	No Water																						
	16/01/2020	No Water																						
	06/02/2020	No Water																						
	09/03/2020	No Water																						
	08/05/2020	No Water																						
	18/05/2020	No Water																						
	02/06/2020	No Water																						
	07/07/2020	No Water																						
	13/08/2020	No Water																						
	07/09/2020	No Water																						

Exxaro - Leeuwpan																								
Sample Number	Date	Comment	Arsenic as As (mg/l)	Boron as B (mg/l)	Barium as Ba (mg/l)	Cadmium as Cd (mg/l)	Cobalt as Co (mg/l)	Chromium as Cr (mg/l)	Copper as Cu (mg/l)	Molybdenum as Mo (mg/l)	Nickel as Ni (mg/l)	Lead as Pb (mg/l)	Selenium as Se (mg/l)	Silicon as Si (mg/l)	Strontium as Sr (mg/l)	Titanium as Ti (mg/l)	Vanadium as V (mg/l)	Zinc as Zn (mg/l)	Mercury as Hg (mg/l)	Lanthanum as La (mg/l)	Lithium as Li (mg/l)	Antimony as Sb (mg/l)	Tin as Sn (mg/l)	Thorium as Th (mg/l)	Thallium as Tl (mg/l)
SANS 241:2015 Strd. Lim. (Operational)			≤ 0.010	≤ 2.400	≤ 0.700	≤ 0.003	-	≤ 0.050	≤ 2	-	≤ 0.070	≤ 0.010	≤ 0.040	-	-	-	-	≤ 5	≤ 0.006	-	-	≤ 0.020	-	-	-
Potable Water			Potable Water																					
LWDL	15/10/2019	Dry																						
	21/11/2019		<0.005	<0.01	0.03	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	21.50	0.40	<0.01	<0.01	0.16	<0.003	<0.01	0.04	<0.01	0.05	0.04	<0.01
	05/12/2019		<0.005	0.07	0.04	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	11.00	0.52	<0.01	<0.01	0.21	<0.003	<0.01	0.08	<0.01	0.04	<0.01	0.06
	16/01/2020		<0.05	0.05	0.03	<0.02	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	0.02	12.40	0.38	<0.01	0.40	0.12	<0.03	<0.01	0.06	<0.01	0.04	0.06	0.08
	06/02/2020		<0.005	0.01	0.03	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	11.30	0.33	<0.01	<0.01	<0.01	<0.003	<0.01	0.06	<0.01	0.25	0.01	0.01
	09/03/2020		<0.005	<0.01	0.04	0.01	<0.01	0.03	0.03	<0.01	<0.01	<0.01	<0.01	10.70	0.31	<0.01	<0.01	0.06	<0.003	<0.01	0.05	0.18	0.05	<0.01	0.02
	08/05/2020		<0.005	<0.01	0.04	<0.002	<0.01	<0.01	0.02	<0.01	<0.01	<0.01	<0.01	11.70	0.39	<0.01	<0.01	0.05	<0.003	<0.01	0.06	<0.01	<0.01	<0.01	0.08
	18/05/2020		<0.005	0.05	0.04	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	11.10	0.37	<0.01	<0.01	0.04	<0.003	<0.01	0.06	0.01	<0.01	<0.01	<0.01
	02/06/2020		<0.005	0.04	0.03	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	9.53	0.35	<0.01	<0.01	0.03	<0.003	<0.01	0.06	<0.01	<0.01	<0.01	<0.01
	07/07/2020		<0.005	0.05	0.07	<0.002	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	9.10	0.43	<0.01	<0.01	0.04	<0.003	<0.01	0.08	<0.01	<0.01	<0.01	<0.01
	13/08/2020		<0.005	<0.01	<0.01	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.32	<0.01	<0.01	<0.01	0.01	<0.003	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	09/09/2020		<0.005	<0.01	0.08	<0.002	<0.01	<0.01	<0.01	0.06	<0.01	<0.01	<0.01	5.45	3.25	<0.01	<0.01	0.14	<0.003	<0.01	0.10	<0.01	<0.01	<0.01	<0.01
PIET-SCHUTTE	15/10/2019	No Water																						
	21/11/2019	No Water																						
	05/12/2019	No Water																						
	16/01/2020	No Water																						
	06/02/2020	No Water																						
	09/03/2020	No Water																						
	08/05/2020	No Water																						
	18/05/2020	No Water																						
	02/06/2020	No Water																						
	07/07/2020	No Water																						
	13/08/2020	No Water																						
	07/09/2020	No Water																						

Exxaro - Leeuwpan																								
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids (mg/l)	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO 4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Ortho Phosphate as P (mg/l)	Turbidity (NTU)	Dissolved Oxygen (DO mg/l)	Sodium Absorption Ratio (indicative)	Escherichia coli (E.coli count per 100ml)	Heterotrophic plate count
SANS 241:2015 Strd. Lim. (Operational)			5.0 - 9.7	≤ 170	≤ 1200	-	-	-		≤ 200	-	≤ 1.5	≤ 300	≤ 500	≤ 2	≤ 0.4	≤ 0.3	≤ 1.5	≤ 12	-	≤ 5	-	-	0	≤1000
Potable Water																								
Comparitive Sample																								
LLBDW A	05/12/2019		8.06	51.0	275	220	180	40.9	28.7	23.0	3.02	0.17	26.2	44.3	0.31	0.03	<0.01	<0.45	<0.35	<0.03	12.00	7.10	0.67	0	3000
	16/01/2020		8.05	51.8	274	211	180	42.7	25.3	23.2	3.05	0.17	26.2	44.6	0.37	0.03	<0.01	<0.45	<0.35	<0.03	7.24	6.42	0.69	0	2500
	06/02/2020		7.88	49.1	257	207	173	35.7	28.6	21.4	2.94	0.16	24.7	39.2	0.02	0.02	<0.01	<0.45	<0.35	<0.03	7.54	7.61	0.64	0	3000
	09/03/2020		7.76	49.3	262	194	178	34.2	26.3	23.4	3.49	0.14	25.3	42.3	0.14	0.01	<0.01	<0.45	<0.35	<0.03	5.25	6.01	0.73	0	3000

Exxaro - Leeuwpan																								
Sample Number	Date	Comment	Arsenic as As (mg/l)	Boron as B (mg/l)	Barium as Ba (mg/l)	Cadmium as Cd (mg/l)	Cobalt as Co (mg/l)	Chromium as Cr (mg/l)	Copper as Cu (mg/l)	Molybdenum as Mo (mg/l)	Nickel as Ni (mg/l)	Lead as Pb (mg/l)	Selenium as Se (mg/l)	Silicon as Si (mg/l)	Strontium as Sr (mg/l)	Titanium as Ti (mg/l)	Vanadium as V (mg/l)	Zinc as Zn (mg/l)	Mercury as Hg (mg/l)	Lanthanum as La (mg/l)	Lithium as Li (mg/l)	Antimony as Sb (mg/l)	Tin as Sn (mg/l)	Thorium as Th (mg/l)	Thallium as Tl (mg/l)
SANS 241:2015 Strd. Lim. (Operational)			≤ 0.010	≤ 2.400	≤ 0.700	≤ 0.003	-	≤ 0.050	≤ 2	-	≤ 0.070	≤ 0.010	≤ 0.040	-	-	-	-	≤ 5	≤ 0.006	-	-	≤ 0.020	-	-	-
Potable Water			Potable Water																					
Comparitive Sample																								
LLBDW A	05/12/2019		<0.005	0.05	0.07	<0.002	<0.01	<0.01	0.01	0.01	<0.01	<0.01	<0.01	7.05	0.15	<0.01	<0.01	0.03	<0.003	<0.01	0.02	<0.01	0.02	<0.01	0.04
	16/01/2020		<0.05	0.05	0.08	<0.02	<0.01	<0.01	0.01	0.01	<0.01	<0.01	<0.01	10.90	0.16	<0.01	<0.01	0.04	<0.03	<0.01	0.02	<0.01	0.04	0.04	0.04
	06/02/2020		<0.005	0.04	0.11	<0.002	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	0.15	<0.01	<0.01	<0.01	<0.003	<0.01	0.08	<0.01	0.02	0.03	<0.01
	09/03/2020		<0.005	<0.01	0.09	0.01	<0.01	0.03	<0.01	<0.01	<0.01	<0.01	<0.01	6.82	0.10	<0.01	<0.01	0.02	<0.003	<0.01	0.02	0.18	0.06	<0.01	0.06

6.2 GROUNDWATER RESULTS

Table 9: Groundwater Sample Results

Exxaro Leeuwpan																					
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Copper (Cu)	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Ortho Phosphate as P (mg/l)
SANS 241 Limit			≥ 5 to ≤ 9.7	≤ 170	≤ 1200	-	-	-	-	≤ 200	-	≤ 1.5	≤ 300	≤ 500	≤ 2	≤ 0.4	≤ 0.3	≤ 2	≤ 1.5	≤ 11	-
Groundwater																					
WWN - 01	Dec-19		7.25	21.80	117.00	72.30	43.40	13.90	9.16	8.63	2.96	0.24	3.1	47.00	0.13	<0.01	0.19	<0.01	<0.45	1.33	<0.03
	Mar-20		7.10	24.10	131.00	91.70	58.40	19.80	10.30	6.24	4.37	0.24	2.9	46.70	0.29	0.23	0.03	<0.01	0.59	0.83	0.04
	Jun-20		7.70	250.00	2288.00	1721.00	132.00	427.00	159.00	40.80	10.90	0.18	15.6	1550.00	0.27	0.05	<0.01	<0.01	<0.45	0.95	0.26
	Sep-20		7.96	59.60	319.00	203.00	146.00	44.00	22.50	35.10	5.85	0.2	49.1	67.40	0.02	0.02	<0.01	0.03	<0.45	1.52	0.29
WWNMB - 16	Dec-19		7.26	28.90	149.00	106.00	106.00	20.20	13.50	6.30	3.08	0.13	6.5	3.17	<0.01	<0.01	<0.01	0.01	3.1	6.26	0.17
	Mar-20		7.17	25.60	124.00	97.80	92.00	20.00	11.60	5.17	5.35	0.17	5.7	2.79	0.04	0.01	<0.01	<0.01	1.77	3.20	0.64
	Jun-20	Dry																			
	Sep-20	Dry																			
WELMB - 13 D	Dec-19		6.60	159.00	1260.00	938.00	70.00	186.00	115.00	20.80	1.75	0.1	4.9	888.00	0.16	1.44	<0.01	<0.01	<0.45	<0.35	<0.03
	Mar-20		6.90	121.00	1068.00	759.00	29.80	141.00	98.90	21.10	3.62	<0.09	4.5	779.00	0.33	1.72	<0.01	<0.01	<0.45	<0.35	<0.03
	Jun-20		7.35	119.00	1056.00	750.00	33.80	137.00	99.00	24.20	2.83	<0.09	5.4	766.00	0.18	0.71	<0.01	<0.01	<0.45	<0.35	<0.03
	Sep-20		7.69	125.00	890.00	649.00	52.40	99.70	97.10	19.40	2.40	<0.09	4.0	635.00	0.11	1.07	<0.01	0.01	<0.45	<0.35	<0.03
WELMB - 13 S	Dec-19		6.32	15.20	79.50	58.20	11.80	11.40	7.23	1.96	0.86	0.13	6.1	43.60	<0.01	0.05	<0.01	<0.01	<0.45	<0.35	0.36
	Mar-20		6.27	17.90	98.10	71.40	15.20	14.00	8.85	2.15	0.77	0.09	4.9	57.60	0.28	0.03	0.32	<0.01	<0.45	<0.35	<0.03
	Jun-20		6.59	22.70	107.00	73.80	13.80	14.00	9.43	5.63	1.14	<0.09	11.0	57.30	0.24	0.01	0.02	<0.01	<0.45	<0.35	<0.03
	Sep-20		7.40	15.90	87.00	57.30	12.80	10.10	7.78	4.37	1.28	<0.09	2.8	51.80	0.27	0.02	0.23	0.01	<0.45	<0.35	0.22
LW - 07	Dec-19	No Access																			
	Mar-20	Dry																			
	Jun-20	Dry																			
	Sep-20		6.89	55.70	297.00	172.00	253.00	32.20	22.30	26.80	4.14	1.9	15.1	19.20	9.36	0.50	<0.01	0.01	9.33	<0.35	0.45
LW - 08	Dec-19	Bees																			
	Mar-20	Bees																			
	Jun-20	Bees																			
	Sep-20																				

Exxaro Leeuwpan																						
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Copper (Cu)	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Ortho Phosphate as P (mg/l)
SANS 241 Limit			≥ 5 to ≤ 9.7	≤ 170	≤ 1200	-	-	-	-	≤ 200	-	≤ 1.5	≤ 300	≤ 500	≤ 2	≤ 0.4	≤ 0.3	≤ 2	≤ 1.5	≤ 11	-
Groundwater																						
RKL - 01	Dec-19	No Access																				
	Mar-20		7.58	265.00	2595.00	1995.00	78.00	496.00	183.00	40.50	11.10	<0.09	13.2	1782.00	0.01	0.03	<0.01	<0.01	<0.45	4.82	<0.03
	Jun-20		6.64	130.00	1002.00	695.00	64.20	174.00	63.20	26.30	5.26	<0.09	6.4	684.00	0.01	0.18	<0.01	<0.01	<0.45	1.02	<0.03
	Sep-20		7.37	102.00	694.00	493.00	150.00	111.00	52.40	28.70	6.08	<0.09	36.1	365.00	0.02	4.51	<0.01	0.01	<0.45	<0.35	<0.03
RKL - 02	Dec-19		7.37	27.20	134.00	74.00	103.00	16.70	7.82	19.80	3.10	0.15	6.9	16.20	0.03	0.05	<0.01	<0.01	0.83	<0.35	<0.03
	Mar-20		7.43	15.00	71.40	32.20	43.20	7.28	3.41	11.60	4.40	0.17	7.3	7.95	<0.01	<0.01	<0.01	<0.01	<0.45	0.71	0.04
	Jun-20		7.59	18.50	98.50	37.50	75.00	7.93	4.31	22.20	4.15	<0.09	4.1	10.80	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.03
	Sep-20		7.40	30.10	159.00	84.50	134.00	17.50	9.90	23.90	4.16	0.13	6.4	12.90	1.18	0.31	<0.01	0.01	1.98	<0.35	<0.03
RKL - 03	Dec-19	Blocked																				
	Mar-20	Blocked																				
	Jun-20	Blocked																				
	Sep-20	Blocked																				
RKL - 04	Dec-19	Blocked																				
	Mar-20	Blocked																				
	Jun-20		7.25	32.40	165.00	97.20	127.00	22.10	10.20	25.30	2.38	0.15	15.1	9.07	0.21	<0.01	<0.01	<0.01	<0.45	0.87	0.05
	Sep-20		7.93	33.70	172.00	101.00	130.00	23.40	10.30	25.90	2.79	0.3	14.3	11.40	0.01	<0.01	<0.01	0.01	<0.45	0.98	0.37
KENMB1	Dec-19	No Borehole																				
	Mar-20	No Access																				
	Jun-20	No Access																				
	Sep-20																					
KENMB - 2 D	Dec-19	Dry																				
	Mar-20	Dry																				
	Jun-20	Dry																				
	Sep-20	Dry																				
KENMB - 2 S	Dec-19		7.70	231.00	2059.00	1569.00	164.00	343.00	173.00	42.20	8.69	<0.09	11.4	1382.00	0.37	0.02	0.38	<0.01	<0.45	<0.35	<0.03
	Mar-20		7.33	226.00	2256.00	1601.00	171.00	359.00	171.00	38.60	8.28	<0.09	10.9	1566.00	0.15	0.02	0.01	<0.01	<0.45	<0.35	0.09
	Jun-20	-																				
	Sep-20		7.89	226.00	1938.00	1440.00	171.00	329.00	150.00	39.00	9.72	<0.09	10.2	1296.00	0.04	<0.01	<0.01	0.01	<0.45	<0.35	0.34
KENMB - 3 D	Dec-19		7.50	137.00	1052.00	737.00	56.80	203.00	55.80	31.90	12.30	<0.09	20.9	684.00	0.04	0.02	<0.01	<0.01	<0.45	2.27	<0.03
	Mar-20		7.55	90.20	636.00	407.00	109.00	111.00	31.60	33.60	10.90	0.11	44.8	327.00	0.05	<0.01	<0.01	<0.01	<0.45	2.66	0.04
	Jun-20		7.55	265.00	2545.00	1878.00	115.00	478.00	166.00	41.70	10.70	<0.09	13.0	1735.00	0.10	<0.01	<0.01	<0.01	<0.45	6.96	<0.03
	Sep-20		7.70	242.00	2168.00	1508.00	73.60	423.00	110.00	53.50	23.00	<0.09	25.7	1471.00	0.02	<0.01	<0.01	0.03	<0.45	4.10	0.06

Exxaro Leeuwpan																					
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Copper (Cu)	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Ortho Phosphate as P (mg/l)
SANS 241 Limit			≥ 5 to ≤ 9.7	≤ 170	≤ 1200	-	-	-	-	≤ 200	-	≤ 1.5	≤ 300	≤ 500	≤ 2	≤ 0.4	≤ 0.3	≤ 2	≤ 1.5	≤ 11	-
Groundwater																					
KENMB - 3 S	Dec-19	Cemented																			
	Mar-20	Cemented																			
	Jun-20	Cemented																			
	Sep-20	Cemented																			
MOAMB - 4	Dec-19		7.21	9.33	45.70	27.80	43.00	5.28	3.55	4.90	3.17	0.17	0.7	1.71	0.16	0.01	0.30	<0.01	<0.45	<0.35	<0.03
	Mar-20		7.23	13.60	64.00	40.90	58.00	7.19	5.57	5.98	4.89	0.12	1.5	3.69	0.16	<0.01	0.02	<0.01	<0.45	<0.35	0.03
	Jun-20		7.56	10.40	50.40	30.10	47.40	5.03	4.25	5.85	4.46	<0.09	1.0	1.05	0.17	<0.01	0.04	<0.01	<0.45	<0.35	0.04
	Sep-20		7.25	9.72	48.80	29.30	44.00	5.07	4.03	5.78	4.02	0.1	<0.48	3.18	0.16	<0.01	0.10	0.01	<0.45	<0.35	<0.03
MOAMB - 7	Dec-19		6.06	8.31	37.50	24.50	12.80	4.38	3.29	2.46	1.68	0.13	2.7	13.30	<0.01	0.03	<0.01	<0.01	<0.45	0.41	<0.03
	Mar-20		6.11	12.50	58.60	37.90	15.20	6.82	5.06	2.37	1.85	<0.09	3.7	22.30	0.34	0.03	0.33	<0.01	<0.45	1.49	0.05
	Jun-20		6.24	10.30	54.30	33.60	18.00	4.96	5.15	4.54	2.13	<0.09	2.9	23.60	<0.01	0.03	0.04	<0.01	<0.45	<0.35	0.06
	Sep-20		6.75	15.40	75.80	54.10	42.00	9.48	7.40	4.27	2.49	<0.09	1.1	24.40	0.32	0.04	0.46	0.02	<0.45	<0.35	0.21
MOAMB - 9	Dec-19		7.11	37.90	184.00	104.00	142.00	24.70	10.30	30.30	3.08	0.25	26.8	3.00	0.18	0.04	0.11	<0.01	<0.45	<0.35	<0.03
	Mar-20		7.02	37.70	190.00	108.00	146.00	26.40	10.10	30.90	3.32	0.21	26.2	5.46	<0.01	0.06	<0.01	<0.01	<0.45	<0.35	0.07
	Jun-20	No Access																			
	Sep-20		7.48	11.10	45.30	28.50	42.60	4.42	4.25	5.80	3.51	0.15	<0.48	0.63	0.12	<0.01	0.03	0.01	<0.45	<0.35	0.26
MOAMB - 10	Dec-19	No Access																			
	Mar-20	No Access																			
	Jun-20	No Access																			
	Sep-20		7.16	11.50	56.50	36.80	44.80	6.34	5.10	5.48	3.84	0.17	<0.48	7.30	0.28	0.01	0.25	0.01	<0.45	<0.35	0.28
WITMB - 14	Dec-19		8.40	53.10	297.00	198.00	167.20	19.80	36.10	31.30	2.38	0.17	17.2	89.80	<0.01	<0.01	<0.01	<0.01	<0.45	<0.35	<0.03
	Mar-20		6.99	24.20	132.00	91.00	60.20	19.70	10.20	5.96	4.28	0.24	3.6	46.70	<0.01	0.31	<0.01	<0.01	0.65	0.82	0.04
	Jun-20		7.45	229.00	2199.00	1602.00	163.00	391.00	152.00	41.30	8.50	<0.09	10.8	1497.00	0.28	<0.01	<0.01	<0.01	<0.45	<0.35	<0.03
	Sep-20		7.12	40.00	233.00	116.00	18.60	30.30	9.80	22.90	4.83	<0.09	3.9	150.00	0.19	0.07	<0.01	0.03	<0.45	<0.35	<0.03
LWG - 01	Dec-19	Blocked																			
	Mar-20	Blocked																			
	Jun-20	Blocked																			
	Sep-20	Blocked																			
LWG - 02	Dec-19		7.10	95.40	628.00	447.00	132.00	100.00	47.90	30.00	6.27	0.11	39.3	325.00	<0.01	0.31	<0.01	<0.01	<0.45	<0.35	<0.03
	Mar-20		7.61	264.00	2525.00	1950.00	78.20	483.00	181.00	39.40	10.80	<0.09	12.9	1730.00	0.01	0.03	<0.01	<0.01	<0.45	4.77	<0.03
	Jun-20		7.36	221.00	2271.00	1637.00	159.00	395.00	158.00	42.20	9.02	<0.09	11.3	1560.00	0.35	<0.01	0.01	<0.01	<0.45	<0.35	<0.03
	Sep-20		7.25	102.00	708.00	518.00	148.00	108.00	60.40	30.60	7.34	<0.09	37.2	371.00	0.15	4.68	<0.01	0.03	<0.45	<0.35	<0.03

Exxaro Leeuwpan																					
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Copper (Cu)	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Ortho Phosphate as P (mg/l)
SANS 241 Limit			≥ 5 to ≤ 9.7	≤ 170	≤ 1200	-	-	-	-	≤ 200	-	≤ 1.5	≤ 300	≤ 500	≤ 2	≤ 0.4	≤ 0.3	≤ 2	≤ 1.5	≤ 11	-
Groundwater																					
LWG - 04	Dec-19	Dry																			
	Mar-20	Dry																			
	Jun-20	Dry																			
	Sep-20																				
WOLMB - 15 D	Dec-19		6.78	117.00	828.00	610.00	55.20	142.00	62.00	13.80	22.20	<0.09	25.9	515.00	0.59	0.03	0.70	0.03	<0.45	2.85	0.14
	Mar-20		6.32	221.00	2212.00	1630.00	41.20	381.00	165.00	39.60	14.70	<0.09	11.2	1557.00	<0.01	0.08	<0.01	<0.01	<0.45	4.27	<0.03
	Jun-20		7.49	219.00	2002.00	1465.00	157.00	356.00	140.00	41.60	8.89	<0.09	11.4	1350.00	0.20	<0.01	<0.01	<0.01	<0.45	<0.35	<0.03
	Sep-20		6.64	228.00	2061.00	1483.00	30.60	363.00	140.00	42.40	8.97	<0.09	12.7	1442.00	0.02	0.03	<0.01	0.03	<0.45	7.52	<0.03
WOLMB - 15 S	Dec-19		7.29	88.40	595.00	436.00	30.20	105.00	42.20	18.80	5.19	<0.09	13.9	381.00	0.04	<0.01	<0.01	<0.01	<0.45	2.37	<0.03
	Mar-20		6.75	50.70	351.00	213.00	15.60	62.00	14.00	18.20	4.51	0.09	11.1	229.00	0.02	<0.01	<0.01	<0.01	<0.45	0.64	<0.03
	Jun-20		7.53	227.00	2126.00	1574.00	164.00	383.00	150.00	42.00	8.88	<0.09	28.4	1415.00	0.26	<0.01	<0.01	<0.01	<0.45	<0.35	<0.03
	Sep-20		7.31	88.70	564.00	387.00	28.40	98.00	34.60	20.20	5.71	<0.09	10.9	367.00	0.03	<0.01	<0.01	0.03	<0.45	2.31	<0.03
LEEMB - 18 D	Dec-19		6.33	166.00	1374.00	1024.00	62.60	242.00	102.00	20.00	6.35	<0.09	6.1	955.00	0.04	0.33	<0.01	<0.01	<0.45	0.98	<0.03
	Mar-20		6.34	205.00	2001.00	1454.00	107.00	358.00	136.00	25.20	7.68	<0.09	5.6	1395.00	0.07	0.13	<0.01	<0.01	<0.45	2.20	0.05
	Jun-20		6.30	205.00	1982.00	1434.00	93.40	355.00	133.00	30.80	7.93	<0.09	6.1	1383.00	0.09	0.13	<0.01	<0.01	<0.45	2.29	<0.03
	Sep-20		6.64	194.00	1614.00	1210.00	84.20	301.00	111.00	23.40	7.77	<0.09	4.1	1108.00	0.02	0.24	<0.01	0.02	<0.45	1.48	0.24
LEEMB - 18 S	Dec-19		7.23	61.40	428.00	268.00	51.60	66.00	25.00	25.20	3.24	0.11	5.7	271.00	0.22	0.20	0.01	<0.01	<0.45	<0.35	<0.03
	Mar-20		7.04	47.10	292.00	170.00	57.80	43.00	15.20	24.90	3.06	0.11	5.4	165.00	<0.01	0.33	<0.01	<0.01	<0.45	<0.35	0.16
	Jun-20		7.14	41.00	262.00	236.00	38.40	34.20	12.20	28.10	3.05	<0.09	5.4	156.00	<0.01	0.19	<0.01	<0.01	<0.45	<0.35	<0.03
	Sep-20		7.02	38.10	235.00	118.00	18.20	32.30	9.10	24.90	3.29	0.1	4.1	150.00	0.19	0.05	<0.01	0.01	<0.45	<0.35	0.17
WTN - 02 D	Dec-19		7.34	18.20	81.60	57.90	69.60	8.54	8.89	9.70	1.26	0.16	7.4	3.78	0.02	0.08	0.03	<0.01	<0.45	<0.35	<0.03
	Mar-20	Dry																			
	Jun-20	Dry																			
	Sep-20																				
WTN - 02 S	Dec-19		7.36	18.20	87.00	59.60	71.20	8.85	9.11	9.77	1.31	0.16	7.8	4.77	0.04	0.12	0.09	<0.01	0.47	0.36	<0.03
	Mar-20		6.82	11.10	51.80	27.50	43.40	4.49	3.97	6.97	0.92	<0.09	6.1	0.93	0.17	0.30	<0.01	<0.01	1.45	<0.35	<0.03
	Jun-20		7.48	14.90	77.30	52.40	68.60	7.99	7.89	10.10	0.96	<0.09	6.2	2.76	0.20	<0.01	<0.01	<0.01	<0.45	<0.35	<0.03
	Sep-20		7.69	15.70	76.20	51.00	66.40	8.81	7.04	10.40	1.30	0.1	5.1	1.91	0.35	0.02	<0.01	0.01	1.04	<0.35	<0.03
WTN - 01 D	Dec-19	Dry																			
	Mar-20		6.72	53.70	368.00	262.00	16.60	50.80	32.90	7.00	1.47	<0.09	4.9	260.00	0.11	0.51	0.04	<0.01	<0.45	<0.35	0.04
	Jun-20		7.44	9.86	48.70	29.30	47.40	4.25	4.54	6.09	3.56	<0.09	1.1	0.61	<0.01	<0.01	0.04	<0.01	<0.45	<0.35	<0.03
	Sep-20		6.74	33.20	196.00	135.00	16.60	23.80	18.30	6.19	2.43	<0.09	3.0	131.00	0.05	0.16	0.01	0.01	<0.45	<0.35	0.28

Exxaro Leeuwpan																					
Sample Number	Date	Comment	pH Value @ 25°C	Electrical Conductivity as EC (mS/m)	Total Dissolved Solids	Total Hardness	Total Alkalinity (pH>4.5)	Calcium as Ca (mg/l)	Magnesium as Mg (mg/l)	Sodium as Na (mg/l)	Potassium as K (mg/l)	Fluoride as F (mg/l)	Chloride as Cl (mg/l)	Sulphate as SO_4 (mg/l)	Iron as Fe (mg/l)	Manganese as Mn (mg/l)	Aluminium as Al (mg/l)	Copper (Cu)	Ammonia as N (mg/l)	Nitrate as N (mg/l)	Ortho Phosphate as P (mg/l)
SANS 241 Limit			≥ 5 to ≤ 9.7	≤ 170	≤ 1200	-	-	-	-	≤ 200	-	≤ 1.5	≤ 300	≤ 500	≤ 2	≤ 0.4	≤ 0.3	≤ 2	≤ 1.5	≤ 11	-
Groundwater																					
WTN - 01 S	Dec-19	Dry																			
	Mar-20		6.63	53.90	372.00	263.00	16.20	51.40	32.80	7.00	1.51	<0.09	4.8	264.00	<0.01	0.52	<0.01	<0.01	<0.45	<0.35	<0.03
	Jun-20		7.35	9.90	47.30	29.40	45.20	4.25	4.56	6.08	3.56	<0.09	1.0	0.67	<0.01	<0.01	0.03	<0.01	<0.45	<0.35	<0.03
	Sep-20		7.48	104.00	707.00	510.00	39.80	79.10	75.80	15.50	2.20	<0.09	3.5	506.00	0.27	0.86	<0.01	0.01	<0.45	<0.35	<0.03
WWN02 - D	Dec-19	Damaged																			
	Mar-20	Damaged																			
	Jun-20	Damaged																			
	Sep-20	Damaged																			
RIE4	Dec-19	Blocked																			
	Mar-20	Blocked																			
	Jun-20	Blocked																			
	Sep-20	Blocked																			
RIE10	Dec-19	No Access																			
	Mar-20	No Access																			
	Jun-20	No Access																			
	Sep-20	No Access																			
RIE10B	Dec-19	No Access																			
	Mar-20	No Access																			
	Jun-20	No Access																			
	Sep-20	No Access																			

7. DISCUSSION

7.1 RECEIVING ENVIRONMENT WATER QUALITY

Surface water monitoring was performed at ten (10) monitoring localities during the September 2020 monitoring period. The following samples were recorded as dry during the site assessment:

- WP01, LSW06, LSW07, LSW08, LSW012 and RD01.

All of the sampled receiving environment monitoring localities water quality analysis indicated exceedances in terms of the DWAF Domestic Guideline Limits for Calcium (Ca), Turbidity and Dissolved Organic Carbon (DOC mg/l). Additional exceedances included the Magnesium (LSW13), Sulphate (LSW13) and Manganese (LSW13). It should be noted that all of the sampled localities recorded the presence of oil and grease.

From the September 2020 results it is evident that the majority of the receiving environment monitoring localities presented overall fair condition. Historically LSW13, has recorded fluctuating and elevated sulphate (SO_4) concentration attributed to oxidation of pyrite associated with coal reserves, however the concentration presented a significant decrease from February 2020. Turbidity within the surface water samples are expected, as turbidity refers to the measurement of the cloudiness or muddiness of water, which is influenced by both natural (flow velocity, rainfall, run-off etc.) and anthropogenic activities (disturbance / mining activities). Overall, the Total Inorganic Nitrogen (TIN), Nitrate (NO_3-N) and Ammonia (NH_3-N) levels remained low, with all the concentrations recording below the detection limit.

Trend graphs relating to pH, Electrical Conductivity, Total Dissolved Solids, Sulphate, and *E. coli* are presented within Appendix C. The following trends were observed:

- Relative stable pH levels persisted throughout the quarterly monitoring period;
- From the salinity and sulphate graphs it is evident that sulphate dominates the surface water quality profiles as similar trends for both EC, TDS and SO_4 is present;
- Microbial activity was not present during September 2020.

Duplicate samples were obtained from monitoring localities LSW05 and WP02 in order to determine the accuracy and precision of inter-laboratory results. Comparison of the calculated TDS and computation of relative percent difference for the duplicate pairs were calculated between a range of 0.76 to 3.57 % for the September 2020 monitoring run, recording within the acceptable range (30%).

7.2 PROCESS WATER QUALITY

Process water monitoring was performed at sixteen (16) monitoring localities during the September 2020 monitoring period. The following samples could not be obtained during the monitoring run:

- KR03, KR04, OWM PIT, OG PIT, OH PIT, OJ PIT, OM PIT, WLV PIT, OJ-O, OJ-S4-DISC, OH-WEATH and OL-OVB (2A+2B). Please refer to the sampling register as presented in Appendix A for details.

The September 2020 exceedances can be summarised as follows:

- KR01A
    - General Authorisation Limit: Electrical Conductivity (EC) and Oil & Grease; and
    - Wastewater WUL limit: Escherichia coli (*E.coli*).
- LSW09
    - General Authorisation Limit: Electrical Conductivity (EC).
- ODN PIT
    - General Authorisation Limit: Electrical Conductivity (EC).
- WP04
    - General Authorisation Limit: Electrical Conductivity (EC).

Discharge of the process water into the receiving environment is prohibited according to the General Authorisation (Section 21f and h, 2013) as it could have limiting effects on the receiving water environment. Note that regular maintenance on process water facilities linings and transfer pipes are vital for water resource protection.

7.3 EFFLUENT WATER QUALITY

Final effluent samples are collected at two (2) monitoring localities inclusive of the Septic tanks at plant and the Final effluent from the sewage plant.

LWP-SP-P was not active during the monitoring period, however historically recorded non-compliant to the set Wastewater WUL limits due to the exceedance of Ammonia, with the General Authorisation limits being exceeded in terms of Ammonia, Suspended Solids and COD. No access was available for LWP-SP-W.

POTABLE WATER QUALITY

Four (4) potable water localities form part of the monitoring programme at Exxaro Leeuwpan Mine. During the September 2020 monitoring period a sample could not be obtained from PIET-SCHUTTE as the pump was inactive.

The potable water quality at Leeuwpan can be described neutral, non-saline and hard, while elevated salinity and Total Hardness was present from Load-Out Bay Offices (LLBDW) and Drinking Water at Laboratory (LWDL) during September 2020. in terms of the recorded pH, TDS and Total Hardness. It should be noted that the elevated salinity is attributed to the significant increase in Sulphates, while the water quality is not representative of the historical results. The high salinity is also confirmed through the in-situ probe results presented within this report. LDWST, LLBDW and LWDL historically presented exceeding Cadmium (Cd) and Antimony (Sb) metal concentrations which poses health risks.

The Load-out Bay Offices Water (LLBDW), Drinking Water Supply Tank (LDWST) and Drinking Water at Laboratory (LWDL) revealed elevated Heterotrophic Plate Counts which renders the water as not suitable for potable purposes. It should be noted that *E.coli* was also present within the LLBDW locality.

Based on the analysed parameters, the potable water poses a risk for infection due to elevated Heterotrophic Plate Counts and thus it is strongly advised that the water be treated and filters regularly disinfected and cleaned as biofilms may be present.

7.4 EXCEEDING VARIABLE DISCUSSION

Salinity (EC and TDS)

A high salinity level in water is associated with a salty taste and does not necessarily slake thirst. Health effects occur only at levels above 370 mS/m and may include disturbance of salt and water balance within infants. Individuals with renal or heart diseases, as well as high blood pressure are particularly vulnerable to adverse effects. Under irrigation, saline soils are formed primarily when high salinity water is used for irrigation; this in return results in a higher leaching fraction, influencing the crop yield. Wetting of the foliage of salt-sensitive crops should be avoided using water with EC concentrations between 40 and 90 mS/m. Increasing problems with encrustation of irrigation pipes and clogging of drip irrigation may be experienced.

Chemical Oxygen Demand

The Chemical Oxygen Demand, or COD for short, is a measure of the oxygen equivalent of the organic matter content in a sample that is susceptible to oxidation by a strong oxidising agent and is therefore an estimate of the organic matter levels present in water. Human activities such as agricultural the production of industrial and domestic wastes are significant sources of organic matter. The organic matter can be present either in dissolved form or as particulate organic matter. The former may be associated with undesirable tastes and odours, while the particulate organic matter contributes to the suspended solids load of a water body (South African Water Quality Guidelines 1996). The COD gives a rough indication of organic matter content in the water that will be available for decomposition (an oxygen depleting process) and ultimately nutrients for plant and algae growth. In terms of wastewater used for irrigation, the organic matter is a substrate for bacterial growth which, at high levels, may therefore lead to bacterial after-growth and fouling or clogging of the irrigation system.

Manganese

Manganese is an essential element in the diet of humans and animals, therefore adverse health effects are expected due to both a shortage and overdose thereof. Manganese may affect the taste of drinking water at concentrations exceeding 0.1 mg/l, while a black precipitate will form in water pipes at concentrations exceeding 0.2 mg/l. The solubility of manganese in groundwater varies from good to poor depending on the nature of the chemical compound.

Adverse aesthetic effects limit the acceptability of manganese-containing water for domestic use at concentrations exceeding 0.15 mg/l. Manganese is nutritionally essential in small amount for cartilage integrity, but supports growth of certain nuisance organisms in water distribution systems, giving rise to taste, odour and turbidity problems. Thus an unpleasant taste and staining of plumbing fixtures and laundry occurs. Health problems associated with manganese concentration in water are rare, neurotoxic effects may occur at high concentrations, but overall manganese is considered to be one of the least potentially harmful of the elements.

Nitrate (NO_3)

High nitrate levels are regularly associated with mining operations as nitrate is a major component of most explosives used in the mining sector and remnants of the nitrate finds its way into process water sources and hence natural resources such as groundwater. Other major sources of nitrate include agricultural practices such as feedlotting and kraaling (nitrate in animal manure) and crop production (nitrate in fertilizer) as well as human sanitation (pit latrines, septic tank systems, sewage treatment plants; in association with phosphate and pathogens) and also certain natural sources such as nitrogen fixation through leguminous plants. When consumed in high concentrations, nitrate causes methaemoglobinaemia due to reduction of nitrate (NO_3) to nitrite (NO_2) in the gastrointestinal tract. Nitrite readily binds to haemoglobin, the red oxygen-carrying blood pigment, rendering it inactive which leads to oxygen deficiency in the body tissues.

Nitrate is a plant nutrient, being the end product of the oxidation of ammonia (NH_3) and nitrite (NO_2). As nitrates are produced by decay of plant, animal and human wastes, pollution of water with nitrate is typically found wherever intensive land use activities take place and nitrate-nitrogen concentrations exceeding 20mg/l are a common occurrence in groundwater. Methods to remove nitrate from water include ion-exchange, reverse osmosis, and biological reduction (denitrification) using a carbon source.

Ammonia/Ammonium

Nitrates (NO3) and Nitrites (NO2) occur together in the environment and interconvert readily, depending on the redox state of the water (reducing or oxidising conditions). Ammonia (NH3) and Ammonium (NH4+) also interconvert readily and their relative proportions of inter-conversion are controlled by water temperature and pH-levels. Inorganic nitrogen is primarily of concern in the aquatic habitat due to its stimulatory effect on aquatic plants and algae and due to the toxicity of ammonia to aquatic life. Ammonia affects the respiratory systems of many aquatic animals, either by inhibiting cellular metabolism or by decreasing oxygen permeability of cell membranes. The methods employed to remove ammonia from water, called air stripping, utilises the characteristic that the toxic forms of ammonia are volatile and predominate at a pH of around 11; so by artificially raising the pH to these levels, the ammonia escapes in the gaseous phase.

Sodium (Na)

The predominant effect of sodium at the concentration usually found in fresh water is aesthetic and usually together with chloride, sodium imparts a salty taste to water. Excessive intake of sodium salts in babies can strain kidneys and the heart, while leading to serious disturbances of salt imbalance regarding water retention. Crops irrigated by water containing high sodium or SAR levels are exposed not only to the root zone sodium, but also to the absorption directly through leaves. Effects of sodium and SAR include leaf burn, scorch and dead tissue along the outside edges of leaves. The crop quality is also affected by sodium-induced leaf injury, especially where leaves are the marketed product and where restrictions on the sodium content of the final product exists.

Sulphate

The presence of sulphate in drinking water can cause noticeable taste defects, and very high levels might cause a laxative effect in unaccustomed consumers. Taste impairment varies with the nature of the associated cation; taste thresholds have been found to range from 250 mg/l for sodium sulphate to 1 000 mg/l for calcium sulphate. It is generally considered that taste impairment is minimal at levels below 250 mg/l.

Turbidity

Turbidity is defined as the light-scattering ability of water and is the measurement of the cloudiness or muddiness of water. Turbidity does note health effects per se, but is an indicator of microbiological water quality and of inefficient water treatment. As elevated turbidities are often associated with the possibility of microbiological contamination, sensitive groups affected will most possible infants under the age of 2. Thus, depending on the nature of the origin of suspended matter causing turbidity, there may be associated health effects. Serious health effect typically occurs under a turbidity greater that fifty NTU (>50 NTU).

Bacteria

Coliforms are used as indicators of the presence of faecal pollution, and thus the possible presence of disease-causing organisms, such as bacteria, viruses or parasites which may give rise to gastro-intestinal diseases typically characterized by diarrhoea, and sometimes fever and other secondary complications. Faecal coliforms, more specifically *Escherichia coli*, are the most common bacterial indicators of faecal pollution by warm blooded animals. If water is consumed, high coliform counts pose health risks in all users and specifically sensitive users. When crops, especially crops of which the leaves (e.g. lettuce, cabbage, spinach) or underground parts (e.g. potatoes, beetroot, carrots) are consumed, are irrigated with water containing high coliform counts, the risk remains that the consumer of the crop can contract gastro-intestinal diseases.

7.5 GROUNDWATER QUALITY

Groundwater monitoring was performed during September 2020 and twenty-two (22) borehole samples were obtained across the site.

Groundwater level depths typically vary between 1 and 54 meters below surface with the historical deepest level measured in monitoring borehole MOAMB9. The groundwater levels form boreholes MOAMB4 and RKL02 presents a water divide flowing towards the Bronkhorstspruit and the Bronkhorstspruit tributary.

The majority of the sampled localities recorded concentrations within the stipulated SANS 241-1:2015 limits presenting satisfactory conditions which included the following monitoring localities: WWN01, WELMB13S, RKL04, MOAMB4, MOAMB9, MOAMB10, WITMB14, WOLMB15S, LEEMB18S, WTN-02S and WTN01D. The remaining monitoring localities presented SANS 241-1:2015 exceedances summarised as follows:

- **WELMB13D**
    - Sulphate (SO_4) and Manganese (Mn);
- **LW07**
    - Fluoride (F), Iron (Fe), Manganese (Mn) and Ammonia (N);
- **RKL01, LWG02**
    - Manganese (Mn);
- **RKL02**
    - Ammonia (N);
- **KENMB2S, KENMB3D, WOLMB15D, LEEMB18D**
    - Electrical Conductivity (EC), Total Dissolved Solids (TDS) and Sulphate (SO^4);
- **MOAMB7**
    - Aluminium (Al); and
- **WTN01S**
    - Sulphate (SO^4) and Manganese (Mn);

According to the Expanded Durov Diagram (Figure 7) and associated Stiff Diagram (Figure 8); the September 2020 reveals that the majority of the aforementioned boreholes are dominated by calcium cations and sulphate anions. Based on the recorded results it is evident that impacts on the boreholes are present which is related to the mining operation.

According to Expanded Durov Diagram (Figure 7) and associated Stiff Diagram (Figure 8), the aquifer regime within the vicinity of the Exxaro Leeuwpan Mine is dominated by the following types of groundwater:

- Field 2: Fresh, clean, relatively young groundwater that has started to undergo Magnesium ion exchange, often found in dolomitic terrain.
- Field 4: Fresh, recently recharged groundwater with HCO_3 and CO_3 dominated ions that has been in contact with a source of SO_4 contamination or that has moved through SO_4 enriched bedrock.
- Field 5: Groundwater that is usually a mix of different types – either clean water from fields 1 and 2 that has undergone SO_4 and NaCl mixing/contamination or old stagnant NaCl dominated water that has mixed with clean water.

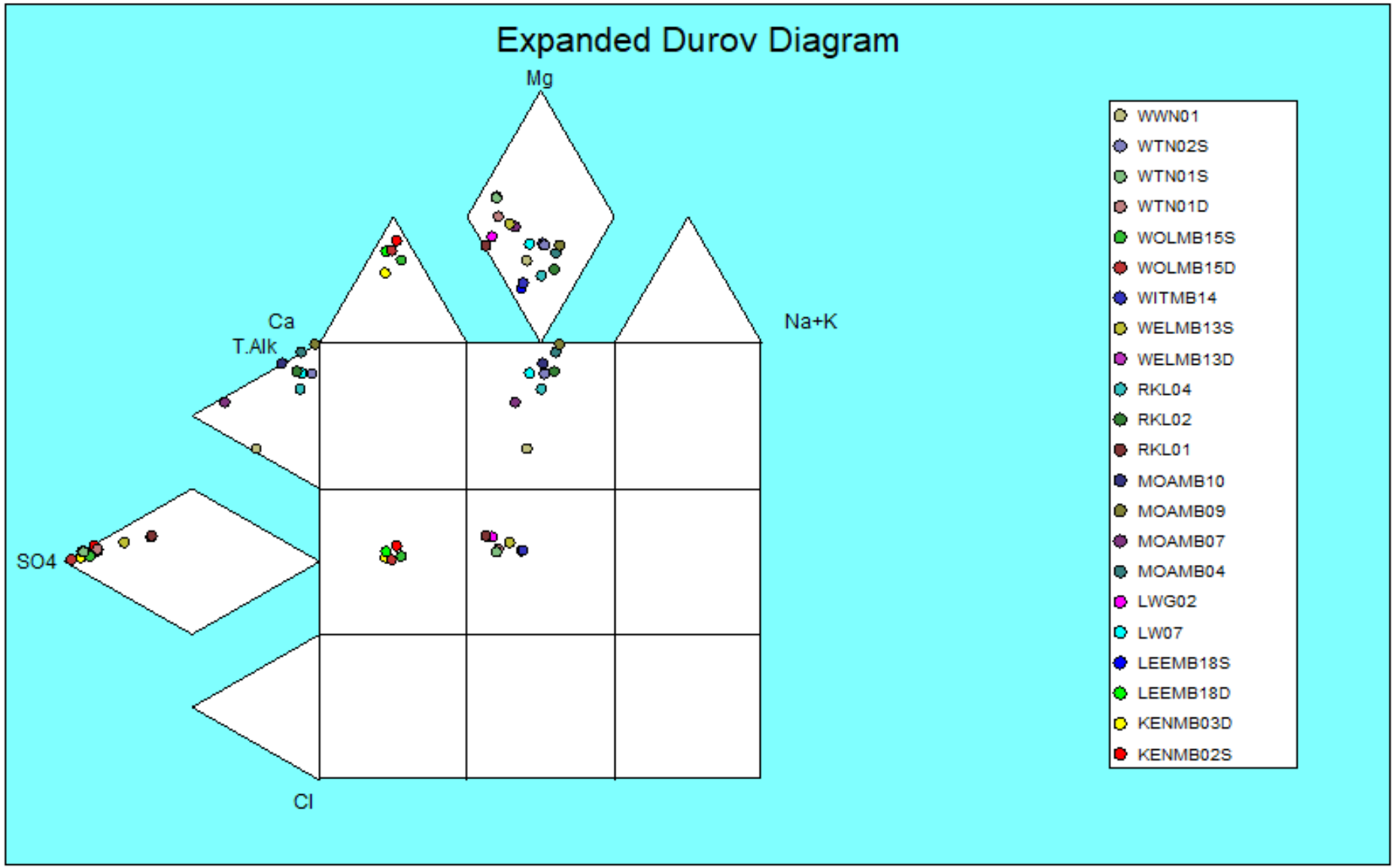


Figure 7: Expanded Durov diagram of groundwater chemistry regarding March 2020

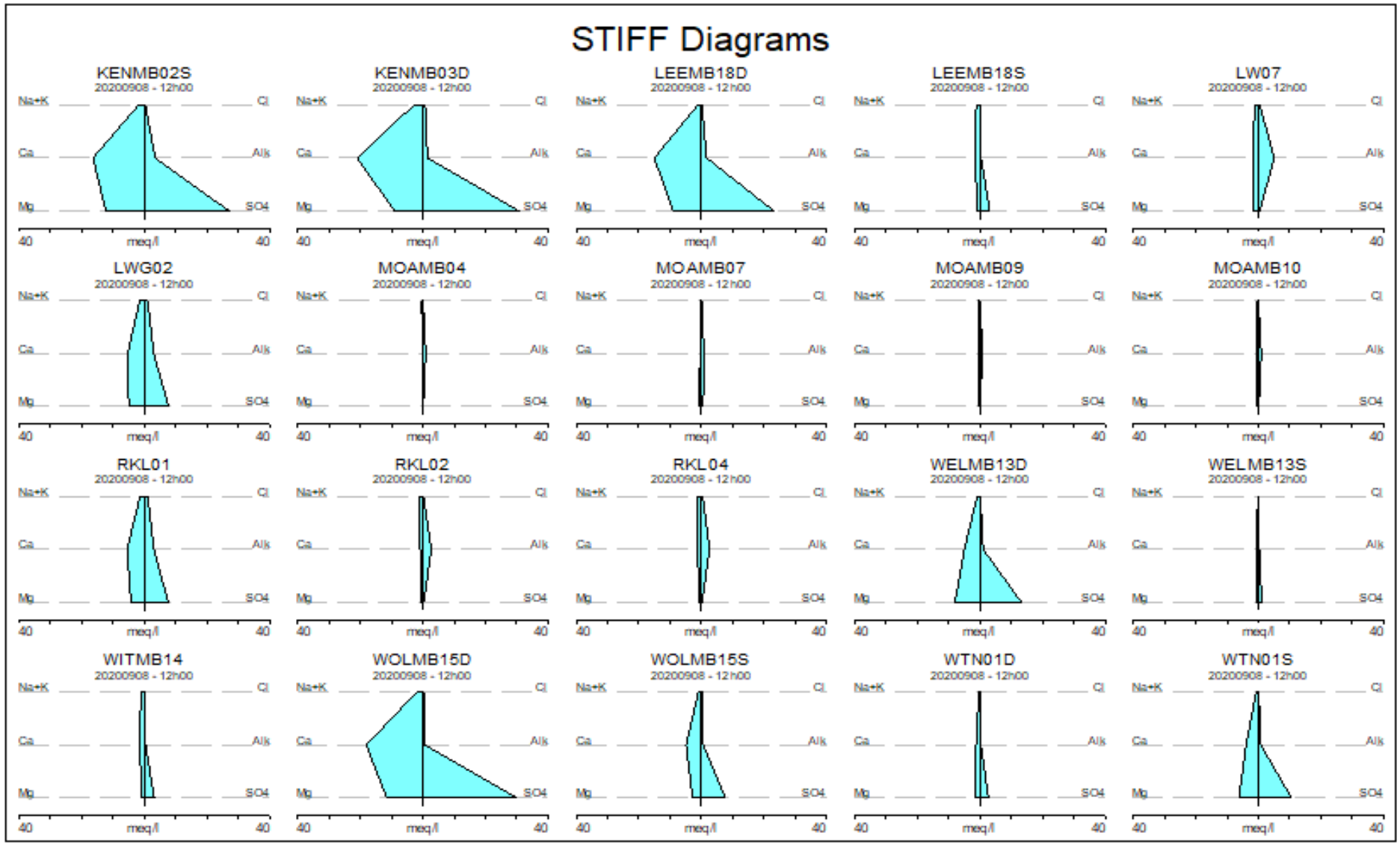


Figure 8: Stiff diagrams of groundwater chemistry regarding September 2020

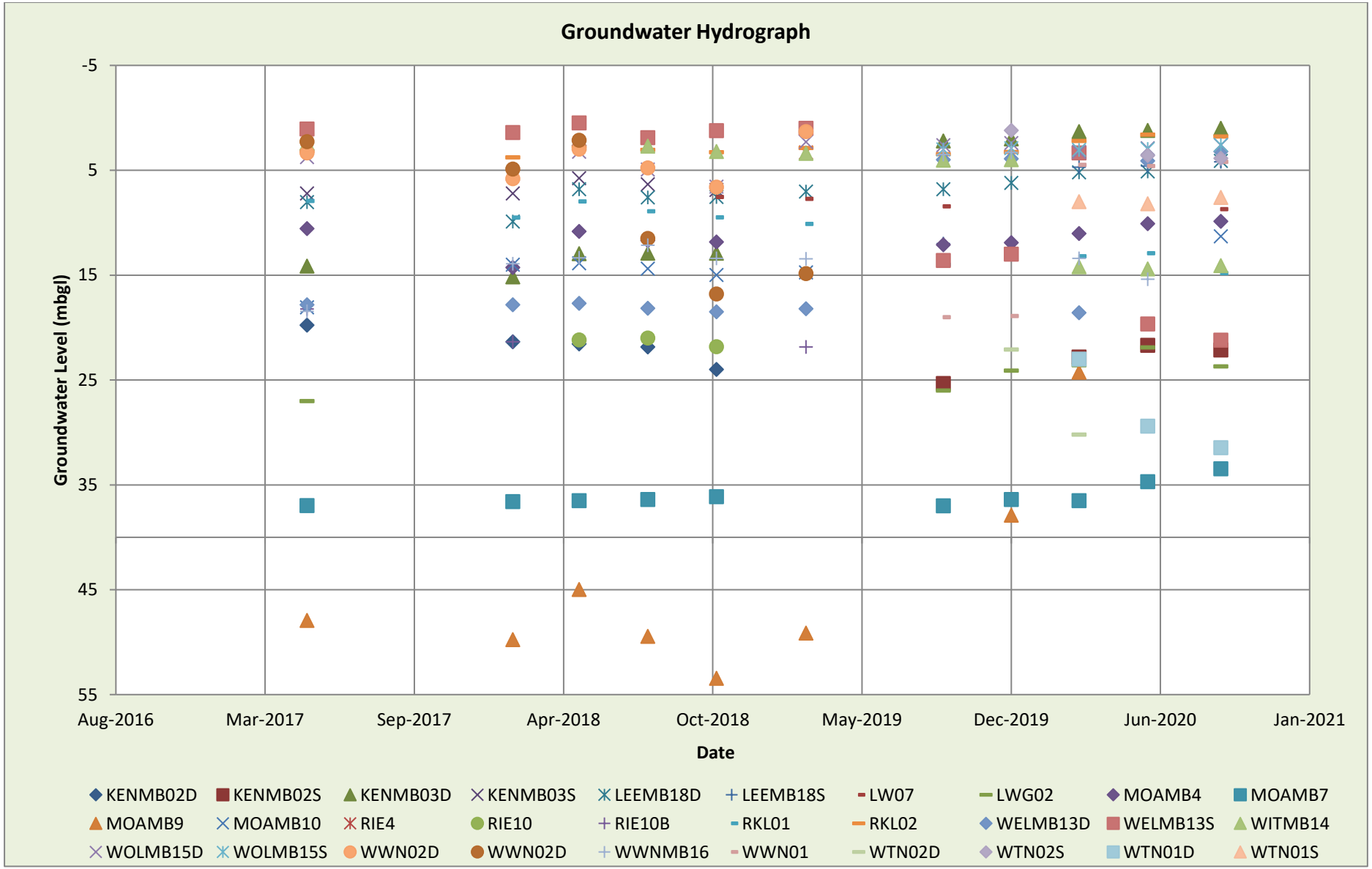


Figure 9: Water levels measured at Exxaro Leeuwpan Operations March 2017 – September 2020

8. CONCLUSION AND ASPECTS TO CONSIDER

The scope of work performed at the Leeuwpan Coal Mine is as per WUL requirements as listed in this report. This report aims to highlight the conditions that have and have not been met with regards to the sampling requirements of the WUL as well as aspects that are to be considered in order to rectify / achieve compliance of the IWUL.

The following findings pertain to the September 2020 surface water monitoring:

- Samples LSW06, LSW07, LSW08, LSW12, WP01, KR03, KR04, RD1, OWM PIY, OG PIT, OH PIT, OJ PIT, OM PIT, WLV PIT, OJ-O, OJ-S4-DISC, OH-WEATH, OL-OVB (2A+2B), LWP-SP-W and PIET-SCHUTTE could not be obtained during the monitoring period;
- The Load-out Bay Offices Water (LLBDW), Drinking Water Supply Tank (LDWST) and Drinking Water at Laboratory (LWDL) revealed elevated Heterotrophic Plate Counts which renders the water as not suitable for potable purposes. It should be noted that *E.coli* was also present within the LLBDW locality;
- The majority of the receiving environment monitoring localities presented overall fair condition;
- Minor exceedances occurred at the process localities, while the majority of the monitoring points were compliant to the stipulated WUL limits. All of the locallities exceeded the WUL limits for EC;
- The final effluent from LWP-SP-P were not active during the monitoring period, however historically recorded non-compliant to the set Wastewater WUL limits due to the exceedance of Ammonia and Chemical Oxygen Demand, with the General Authorisation limits being exceeded in terms of Ammonia. No access was available for LWP-SP-W; and
- During the monthly monitoring period of September 2020, most of the parameters analysed remained relatively constant with no major changes presented, when compared to August 2020.

The following findings pertain to the September 2020 groundwater monitoring:

- Samples EMPR02/E2, KENMB1, KENMB2-D, KENMB3-S, LW08, LW10, LWG01, LWG04, MOAMB10, RIE10, RIE10B, RIE4, RKL03, WTN02-D, WWNMB 16 and WWN02D could not be obtained during the monitoring period;
- The majority of the monitoring boreholes recorded satisfactory concentrations compared to SANS241-1:2015; and
- From the monitoring results some boreholes presented elevated salinity and sulphate concentrations which may be attributed to the mining operation.

Aspects to consider:

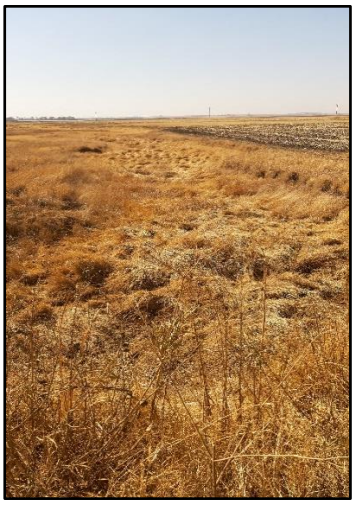
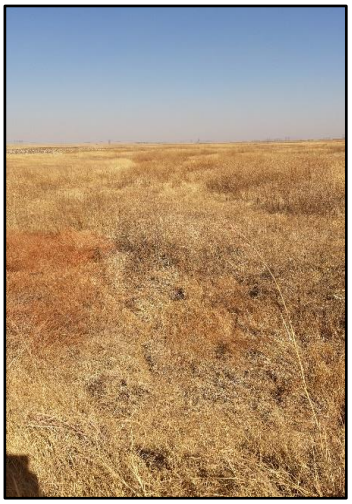
- The potable water poses a risk for infection based on the elevated Heterotrophic Plate Counts, as well as a health risk related to the historically Chromium (Cr) and Antimony (Sb) concentrations recorded from LDWST and LWDL. It is strongly advised that the water be treated and filters regularly disinfected and cleaned, as well as consumption of LDWST and LWDL be terminated until the metal concentrations have been removed;
- Clean and dirty stormwater must be separated as reasonably possible;
- All waste water be contained and not released into the receiving environment;
- All spills and incidents be reported to the SHEQ manager;
- Immediate reporting of any polluting or potentially polluting incidents be implemented.

APPENDIX A – SAMPLING REGISTER

Surface Water Monitoring Localities:

Sample ID	Details	Photo
WP01	**Latitude (DD):** S26.17799 **Longitude (DD):** E28.70221 **Description:** Bronkhorstspruit tributary, upstream **Frequency:** Monthly **Sample Date:** 08/09/2020 **Sampling status:** Dry **Time:** N/A	
WP02	**Latitude (DD):** S26.15510 **Longitude (DD):** E28.70260 **Description:** Bronkhorstspruit tributary, downstream **Frequency:** Monthly **Sample Date:** 08/09/2020 **Sampling status:** Sampled **Time:** 10:24	

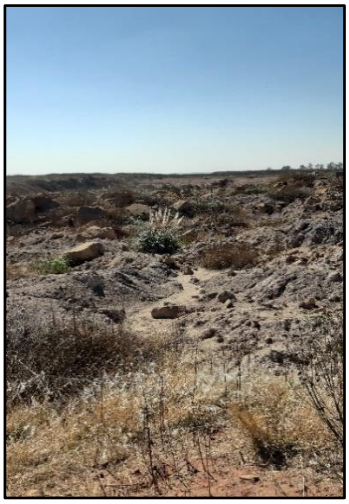
Sample ID	Details	Photo
LSW03	**Latitude (DD):** S26.16279 **Longitude (DD):** E28.76881 **Description:** Bronkhorstspruit at Delmas Silica, downstream **Frequency:** Monthly **Sample Date:** 08/09/2020 **Sampling status:** Sampled **Time:** 11:51	
LSW05	**Latitude (DD):** S26.13750 **Longitude (DD):** E28.75700 **Description:** Bronkhorstspruit, downstream **Frequency:** Monthly **Sample Date:** 08/09/2020 **Sampling status:** Sampled **Time:** 10:52	
LSW06	**Latitude (DD):** S26.14390 **Longitude (DD):** E28.79550 **Description:** Weltevredenspruit, upstream **Frequency:** Monthly **Sample Date:** 07/09/2020 **Sampling status:** Dry **Time:** N/A	

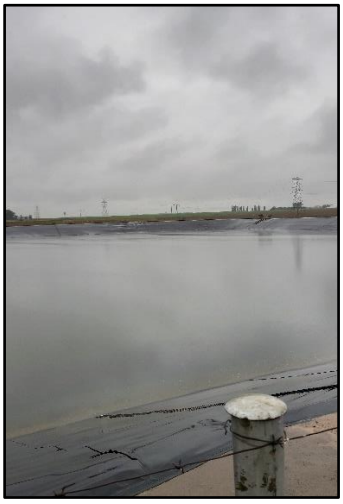
Sample ID	Details	Photo
LSW07	**Latitude (DD):** S26.18860 **Longitude (DD):** E28.77635 **Description:** Bronkhorstspruit, upstream **Frequency:** Monthly **Sample Date:** 07/08/2020 **Sampling status:** Dry **Time:** N/A	
LSW08	**Latitude (DD):** S26.23022 **Longitude (DD):** E28.76264 **Description:** Bronkhorstspruit, upstream of block OI **Frequency:** Monthly **Sample Date:** 07/09/2020 **Sampling status:** Dry **Time:** N/A	
LSW12	**Latitude (DD):** S26.13610 **Longitude (DD):** E28.76410 **Description:** Downstream of River Diversion 2, between RD2 and LSW05 **Frequency:** Monthly **Sample Date:** 07/09/2020 **Sampling status:** Dry **Time:** N/A	

Sample ID	Details	Photo
LSW13	**Latitude (DD):** S26.14380 **Longitude (DD):** E28.77560 **Description:** Water from Stuart Coal **Frequency:** Monthly **Sample Date:** 08/09/2020 **Sampling status:** Sampled **Time:** 10:14	
RD1	**Latitude (DD):** S26.14930 **Longitude (DD):** E28.76450 **Description:** Bronkhorstspruit at haul road **Frequency:** Monthly **Sample Date:** 07/09/2020 **Sampling status:** Not Sampled - Dry **Time:** N/A	
Process Monitoring Localties		
KR01A	**Latitude (DD):** S26.18087 **Longitude (DD):** E28.72995 **Description:** Kenbar Return Water Dam **Frequency:** Monthly **Sample Date:** 09/09/2020 **Sampling status:** Sampled **Time**: 13:30	

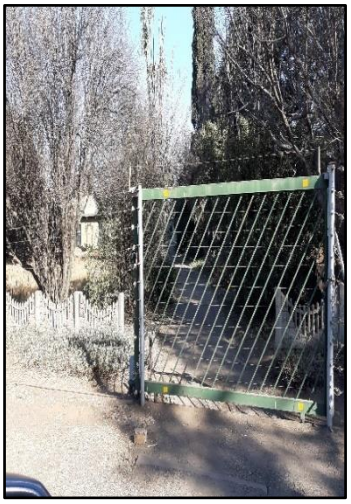
Sample ID	Details	Photo
KR03	**Latitude (DD):** S26.18197 **Longitude (DD):** E28.73827 **Description:** Downstream of workshop oil separator sump **Frequency:** Monthly **Sample Date:** 07/09/2020 **Sampling status:** Dry **Time:** N/A	
KR04	**Latitude (DD):** S26.18672 **Longitude (DD):** E28.73381 **Description:** Marsh area next to workshop road **Frequency:** Monthly **Sample Date:** 08/09/2020 **Sampling status:** Dry **Time:** N/A	
LSW09	**Latitude (DD):** S26.16601 **Longitude (DD):** E28.72541 **Description:** Pollution Control Dam (PCD) **Frequency:** Monthly **Sample Date:** 09/09/2020 **Sampling status:** Sampled **Time:** 12:14	

Sample ID	Details	Photo
ODN_PIT	**Latitude (DD):** S26.17122 **Longitude (DD):** E28.72381 **Description:** OD Pit Water **Frequency:** Monthly **Sample Date:** 09/09/2020 **Sampling status:** Sampled **Time:** 11:37	
OG_PIT	**Latitude (DD):** S26.17119 **Longitude (DD):** E28.73397 **Description:** OG Pit Water (Backfilled pit) **Frequency:** Monthly **Sample Date:** 08/09/2020 **Sampling status:** Rehabilitated **Time:** N/A	
OH_PIT	**Latitude (DD):** S26.16698 **Longitude (DD):** E28.75338 **Description:** OH Pit Water (Backfilled pit) **Frequency:** Monthly **Sample Date:** 08/09/2020 **Sampling status:** Rehabilitated **Time:** N/A	

Sample ID	Details	Photo
OJ_PIT	**Latitude (DD):** S26.16854 **Longitude (DD):** E28.74505 **Description:** OJ Pit Water **Frequency:** Monthly **Sample Date:** 08/09/2020 **Sampling status:** Rehabilitated **Time:** N/A	
OM_PIT	**Latitude (DD):** S26.17278 **Longitude (DD):** E28.74875 **Description:** OM Pit Water **Frequency:** Monthly **Sample Date:** 09/09/2020 **Sampling status:** Rehabilitated **Time:** N/A	
OWM_PIT	**Latitude (DD):** S26.14440 **Longitude (DD):** E28.79241 **Description:** OWM (Moabsvelden) Pit Water **Frequency:** Monthly **Sample Date:** 09/09/2020 **Sampling status:** Dry **Time:** N/A	

Sample ID	Details	Photo
WLV_PIT	**Latitude (DD):** S26.12888 **Longitude (DD):** E28.76050 **Description:** Weltevreden Pit **Frequency:** Monthly **Sample Date:** 09/09/2020 **Sampling status:** Rehabilitated **Time:** N/A	
WP04	**Latitude (DD):** S26.17234 **Longitude (DD):** E28.70640 **Description:** New Witklip Return Water Dam **Frequency:** Monthly **Sample Date:** 09/09/2020 **Sampling status:** Sampled **Time:** 11:44	
Effluent Monitoring Localties		

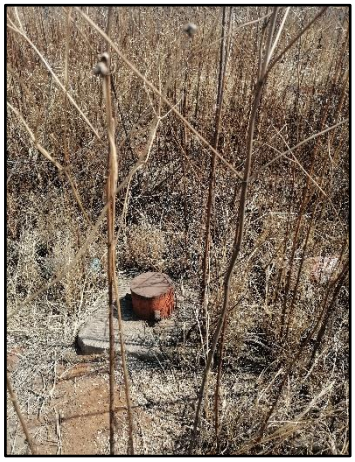
Sample ID	Details	Photo
LWP_SP_P	**Latitude (DD):** S26.1716 **Longitude (DD):** E28.7302 **Description:** Final effluent from septic tanks at plant **Frequency:** Monthly **Sample Date:** 07/09/2020 **Sampling status:** Not Active **Time:** N/A	
LWP_SP_W	**Latitude (DD):** S26.1812 **Longitude (DD):** E28.7396 **Description:** Final effluent at sewage plant behind workshop **Frequency:** Monthly **Sample Date:** 08/09/2020 **Sampling status:** No Access **Time:** N/A	
Additional Monitoring Localities		
Potable Monitoring Localities		
LDWST	**Latitude (DD):** S26.18005 **Longitude (DD):** E28.73602 **Description:** Drinking water supply tank **Frequency:** Monthly **Sample Date:** 09/09/2020 **Sampling status:** Sampled **Time:** 13:20	

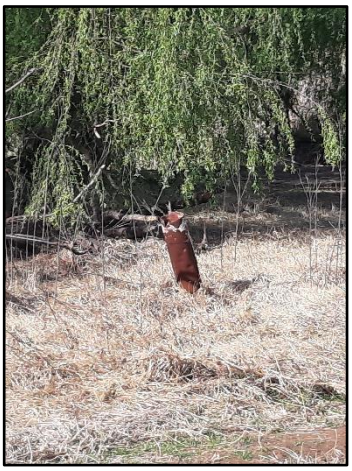
Sample ID	Details	Photo
LLBDW	**Latitude (DD):** S26.16590 **Longitude (DD):** E28.72990 **Description:** Load-out Bay Offices Drinking Water **Frequency:** Monthly **Sample Date:** 09/09/2020 **Sampling status:** Sampled **Time**: 08:15	
LWDL	**Latitude (DD):** S26.17128 **Longitude (DD):** E28.72797 **Description:** Drinking Water at Laboratory **Frequency:** Monthly **Sample Date:** 09/09/2020 **Sampling status:** Sampled **Time:** 12:18	
PIET-SCHUTTE	**Latitude (DD):** S26.14150 **Longitude (DD):** E28.80170 **Description:** Drinking Water on Piet Schutte's Farm **Frequency:** Monthly **Sample Date:** 07/09/2020 **Sampling status:** No water **Time:** N/A	

Groundwater Monitoring Localities:

Sample ID	Details	Photo
KENMB1	**Latitude (DD):** S 26° 10.9176' **Longitude (DD):** E 28°44.2698' **Description:** Fuel Dispensary **Sample Date:** 07/09/2020 **Sampling status:** Borehole destroyed during construction **Time**: N/A **Water level:** N/A	
KENMB2-D	**Latitude (DD):** S 26°10.7604' **Longitude (DD):** E 28°43.8452' **Description:** Silver Dam 2 **Frequency:** Quarterly **Sample Date:** 07/09/2020 **Sampling status:** Dry at 9.80m **Time**: N/A **Water level:** N/A	
KENMB2-S	**Latitude (DD):** S 26° 10.761' **Longitude (DD):** E 28°43.827' **Description:** Silver Dam 1 **Frequency:** Quarterly **Sample Date:** 07/09/2020 **Sampling status:** Sampled **Time**: 11:34 **Water level:** 22.14m	

Sample ID	Details	Photo
KENMB3-D	**Latitude (DD):** S 26°10.1738' **Longitude (DD):** E 28°44.2325' **Description:** Plant/Stockpile 1 **Frequency:** Quarterly **Sample Date:** 09/09/2020 **Sampling status:** Can't access with pump - Sampled with bailer **Time**: 13:01 **Water level:** 1.01m	
KENMB3-S	**Latitude (DD):** S 26°10.2819' **Longitude (DD):** E 28°43.8080' **Description:** Plant/Stockpile 2 **Frequency:** Quarterly **Sample Date:** 09/09/2020 **Sampling status:** Cemented – Not Sampled **Time**: N/A **Water level:** N/A	
LEEMB18-D	**Latitude (DD):** S 26°10.0902' **Longitude (DD):** E 28°43.6521' **Description:** Plant Conveyor 2 **Frequency:** Quarterly **Sample Date:** 09/09/2020 **Sampling status:** Sampled **Time**: 12:33 **Water level:** 4.10m	

Sample ID	Details	Photo
LEEMB 18-S	**Latitude (DD):** S 26°10.0902' **Longitude (DD):** E 28°43.6521' **Description:** Plant Conveyor 2 **Frequency:** Quarterly **Sample Date:** 09/09/2020 **Sampling status:** Sampled **Time**: 12:22 **Water level:** 4.20m	
LW07	**Latitude (DD):** S 26°09.9706' **Longitude (DD):** E 28°42.6314' **Description:** North of Witklip **Frequency:** Quarterly **Sample Date:** 08/09/2020 **Sampling status:** Sampled **Time**: 12:30 **Water level:** 8.70m	
LW08	**Latitude (DD):** S 26°11.0940' **Longitude (DD):** E 28°43.6227' **Description:** South West of Kenbar **Frequency:** Quarterly **Sample Date:** 08/09/2020 **Sampling status:** Not Sampled **Time**: N/A **Water level:** N/A	

Sample ID	Details	Photo
LWG01	**Latitude (DD):** S 26°10.7796' **Longitude (DD):** E 28°43.7256' **Description:** South of Kenbar **Frequency:** Quarterly **Sample Date:** 07/09/2020 **Sampling status:** Blocked by vegetation – Needs to be re-open **Time**: N/A **Water level:** N/A	
LWG02	**Latitude (DD):** S 26°10.7461' **Longitude (DD):** E 28°44.2200' **Description:** South East of Kenbar **Frequency:** Quarterly **Sample Date:** 09/09/2020 **Sampling status:** Sampled **Time**: 11:16 **Water level:** 23.70m	
LWG04	**Latitude (DD):** S 26°10.4568' **Longitude (DD):** E 28° 45.3546' **Description:** Moabsvelden Groundwater **Frequency:** Quarterly **Sample Date:** 08/09/2020 **Sampling status:** Dry at 48,0m – Not Sampled **Time**: N/A **Water level:** N/A	

Sample ID	Details	Photo
MOAMB10	**Latitude (DD):** S 26°09.9010' **Longitude (DD):** E 28°45.9177' **Description:** Block OI New Mine Area 1 **Frequency:** Quarterly **Sample Date:** 09/09/2020 **Sampling status:** Sampled **Time**: 10:41 **Water level:** 11.31m	
MOAMB4	**Latitude (DD):** S 26°10.0472' **Longitude (DD):** E 28°44.6280' **Description:** Block OH **Frequency:** Quarterly **Sample Date:** 09/09/2020 **Sampling status:** Sampled **Time**: 10:55 **Water level:** 9.87m	
MOAMB7	**Latitude (DD):** S 26°09.2321' **Longitude (DD):** E 28°45.3272' **Description:** Block OJ / Stuart Coal Upstream **Frequency:** Quarterly **Sample Date:** 09/09/2020 **Sampling status:** Sampled **Time**: 10:32 **Water level:** 33.46m	

Sample ID	Details	Photo
MOAMB9	**Latitude (DD):** S 26°10.5353' **Longitude (DD):** E 28°46.0158' **Description:** Block OI New Mine Area 2 **Frequency:** Quarterly **Sample Date:** 07/09/2020 **Sampling status:** Sampled **Time**: 11:04 **Water level:** 21.49m	
RIE10	**Latitude (DD):** S 26°12.0996' **Longitude (DD):** E 28°45.8058' **Description:** Rietkuil Monitoring Borehole **Frequency:** Quarterly **Sample Date:** 08/09/2020 **Sampling status:** BH fitted with pump – no access for sampling **Time**: N/A **Water level:** N/A	
RIE10B	**Latitude (DD):** S 26°12.0783' **Longitude (DD):** E 28°45.8202' **Description:** Rietkuil Monitoring Borehole **Frequency:** Quarterly **Sample Date**: 08/09/2020 **Sampling status:** BH fitted with pump – no access for sampling **Time**: N/A **Water level:** N/A	

Sample ID	Details	Photo
RIE4	**Latitude (DD):** S 26°11.3292' **Longitude (DD):** E 28°46.104' **Description:** Rietkuil Monitoring Borehole **Frequency:** Quarterly **Sample Date:** 08/09/2020 **Sampling status:** Blocked by ground and vegetation – Needs to be re-open **Time**: N/A **Water level:** N/A	
RKL01	**Latitude (DD):** S 26°11.0684' **Longitude (DD):** E 28°44.6443' **Description:** Rietkuil Monitoring Borehole **Frequency:** Quarterly **Sample Date:** 09/09/2020 **Sampling status:** Sampled **Time**: 11:29 **Water level:** 14.80m	
RKL02	**Latitude (DD):** S 26°10.9936' **Longitude (DD):** E 28°45.9942' **Description:** Rietkuil Monitoring Borehole **Frequency:** Quarterly **Sample Date:** 09/09/2020 **Sampling status:** Sampled **Time**: 08:35 **Water level:** 1.71m	

Sample ID	Details	Photo
RKL03	**Latitude (DD):** S 26°11.355' **Longitude (DD):** E 28°46.248' **Description:** Rietkuil Monitoring Borehole **Frequency:** Quarterly **Sample Date:** 08/09/2020 **Sampling status:** Blocked by glass bottles – Needs to be re-open **Time**: N/A **Water level:** N/A	
RKL04	**Latitude (DD):** S 26°11.8884' **Longitude (DD):** E 28°44.5146' **Description:** De Denne Monitoring Borehole upstream of Block UI **Frequency:** Quarterly **Sample Date:** 08/09/2020 **Sampling status:** Sampled **Time**: 09:24 **Water level:** N/A (Tap)	
WELMB13-D	**Latitude (DD):** S 26°08.6306' **Longitude (DD):** E 28°46.7083' **Description:** Moabsvelden 1 **Frequency:** Quarterly **Sample Date:** 09/09/2020 **Sampling status:** Sampled **Time**: 10:04 **Water level:** 3.20m	

Sample ID	Details	Photo
WELMB13-S	**Latitude (DD):** S 26°08.6364' **Longitude (DD):** E 28°46.6961' **Description:** Moabsvelden 2 **Frequency:** Quarterly **Sample Date:** 09/09/2020 **Sampling status:** Sampled **Time**: 09:38 **Water level:** 21.20m	
WITMB14	**Latitude (DD):** S 26°10.0137' **Longitude (DD):** E 28°42.3247' **Description:** Block OA **Frequency:** Quarterly **Sample Date:** 08/09/2020 **Sampling status:** Sampled **Time**: 15:29 **Water level:** 14.10m	
WOLMB15-D	**Latitude (DD):** S 26°09.9538' **Longitude (DD):** E 28°43.4233' **Description:** ODN/PCD1 **Frequency:** Quarterly **Sample Date:** 09/09/2020 **Sampling status:** Sampled **Time**: 11:51 **Water level:** 2.60m	

Sample ID	Details	Photo
WOLMB15-S	**Latitude (DD):** S 26°09.9548' **Longitude (DD):** E 28°43.4306' **Description:** ODN/PCD2 **Frequency:** Quarterly **Sample Date:** 09/09/2020 **Sampling status:** Sampled **Time**: 11:58 **Water level:** 2.58m	
WTN02-D	**Latitude (DD):** S 26°8.7840' **Longitude (DD):** E 28°46.1604' **Description:** Weltevreden Monitoring Borehole - Deep **Frequency:** Quarterly **Sample Date:** 08/09/2020 **Sampling status:** Dry at 30.2m **Time**: N/A **Water level**: N/A	
WTN02-S	**Latitude (DD):** S 26°8.7840' **Longitude (DD):** E 28°46.1598' **Description:** Weltevreden Monitoring Borehole - Shallow **Frequency:** Quarterly **Sample Date:** 08/09/2020 **Sampling status:** Sampled **Time**: 11:15 **Water level:** 3.86m	

Sample ID	Details	Photo
WTN01-D	**Latitude (DD):** S 26°8.0976' **Longitude (DD):** E 28°45.942' **Description:** Weltevreden Monitoring Borehole **Frequency:** Quarterly **Sample Date:** 09/09/2020 **Sampling status:** Sampled **Time**: 09:44 **Water level:** 31.46m	
WTN01-S	**Latitude (DD):** S 26° 8.0976' **Longitude (DD):** E 28°45.942' **Description:** Weltevreden Monitoring Borehole - Shallow **Frequency:** Quarterly **Sample Date:** 09/09/2020 **Sampling status:** Sampled **Time**: 10:07 **Water level:** 7.6m	
WWNMB16	**Latitude (DD):** S 26°10.7110' **Longitude (DD):** E 28°42.6609' **Description:** Block UB **Frequency:** Quarterly **Sample Date:** 07/09/2020 **Sampling status:** Dry at 15.40m **Time**: N/A **Water level:** N/A	

Sample ID	Details	Photo
WWN01	**Latitude (DD):** S 26° 10.4628' **Longitude (DD):** E 28° 43.0332' **Description:** Wolwenfontein Monitoring Borehole **Frequency:** Quarterly **Sample Date:** 07/09/2020 **Sampling status:** Sampled **Time**: 13:13 **Water level:** 4.20m	
WWN02D	**Latitude (DD):** S 26°10.4475' **Longitude (DD):** E 28°43.0969' **Description:** Wolwenfontein Monitoring Borehole - Deep **Frequency:** Quarterly **Sample Date:** 07/09/2020 **Sampling status:** Borehole damaged, no access – Not Sampled **Time**: N/A **Water level:** N/A	

APPENDIX B – PROBE FIELD MEASUREMENTS

Locality	Temp (C)	Baro (mb)	pH	pHmV	ORP (REDOX)	DO (% Sat)	DO (mg/L)	EC (uS/cm @25C)	RES (Ohms.cm)	TDS (mg/L)	SAL (PSU)	SSG (st)	Turbidity (NTU)
KENMB2-S	19.2	850	7.09	-53.7	-18.2	4.3	0.33	2053	547	1334	1.04	0	0
Farmer pipe	16.93	851	7.77	-89.2	-2.5	9.9	0.81	325	3636	211	0.1	0	0
Farmer tank	16.53	851	7.69	-85.2	-0.9	11.3	0.92	328	3636	213	0.1	0	0
Farmer tap	17.38	851	8.12	-107.2	8.5	8.8	0.7	330	3546	214	0.1	0	0
KENMB3-D	18.5	851	7.68	-84.6	105.5	83.3	6.55	2135	534	1387	1.08	0	0
KR01A	22.78	850	8.07	-105.9	82.2	74.9	5.35	2205	474	1433	1.11	0	0
LDWST	23.3	849	7.83	-93.1	65.5	46.3	3.32	583	1769	378	0.24	0	0
LEEMB18-D	22.5	851	7.77	-89.8	92.3	105.6	7.71	394	2659	256	0.13	0	0
LEEMB18-S	21.8	851	7.12	-55.6	100	53	3.91	435	2444	282	0.14	0	0
LLBDW	17.63	854	8.67	-136.2	7.9	131.6	10.81	2371	491	1541	1.2	0	0.8
LSW03*	22.38	854	8.24	-115	-0.5	15.8	1.13	385	2732	250	0.12	0	0
LSW03A	22.38	854	8.24	-115	-0.5	15.8	1.13	385	2732	250	0.12	0	0
LSW05*	18.25	855	8.35	-119.9	42.2	15.9	1.26	441	2604	286	0.14	0	0
LSW05A	18.25	855	8.35	-119.9	42.2	15.9	1.26	441	2604	286	0.14	0	0
LSW09	21.9	852	7.9	-96.6	45.4	97	7.11	2404	442	1562	1.21	0	0
LSW13	17.95	855	8.32	-118.2	-6.9	59.4	4.75	492	2347	319	0.16	0	0
LW07	23.03	854	8.04	-104.3	-171.1	68.6	4.93	468	2217	304	0.15	0	33.3
LWDL	21.5	852	7.95	-99.4	59.1	93.6	6.94	421	2544	273	0.13	0	0
LWG02	25.33	852	7.5	-75.6	-49.3	60.2	4.12	866	1148	562	0.36	0	8.9
MOAMB10	19.3	854	7.22	-60.4	59.1	22.1	1.72	120	9345	78	0.04	0	16.1
MOAMB4	21.45	852	8.2	-112.3	38.4	59.6	4.43	95	11235	61	0.03	0	0
MOAMB7	19.4	854	7.38	-69.3	49.1	22.8	1.77	132	8474	85	0.04	0	10
MOAMB9	20.08	852	7.98	-100.7	31.3	55.2	4.21	96	11494	62	0.03	0	0
ODN_PIT	24.48	853	7.58	-80.3	21.3	87.3	6.1	2205	458	1433	1.11	0	0
RKL01	23.1	852	7.27	-63.6	-65.5	41.4	2.95	898	1154	583	0.38	0	1.6
RKL02	18.23	854	8.96	-151.2	-172.8	55.1	4.39	216	5319	140	0.07	0	0
RKL04	17.25	851	8	-101	-10.3	17.5	1.42	319	3676	207	0.1	0	0
WELMB13-D	16.48	855	8.03	-102.7	-106.2	36	2.98	1117	1070	726	0.53	0	56.3
WELMB13-S	19.03	855	8.46	-125.4	2	67.5	5.3	173	6493	112	0.06	0	0
WITMB14	22.1	851	7.82	-92.7	84.5	61.1	4.48	365	2898	237	0.12	0	0
WOLMB15-D	17.58	853	7.53	-76.9	51.9	40.2	3.22	1663	701	1080	0.82	0	0
WOLMB15-S	15.45	853	7.51	-75.7	49.7	40.4	3.4	885	1383	575	0.37	0	0
WP02*	24.08	855	8.16	-110.9	32.9	13.9	0.98	396	2570	257	0.13	0	0
WP02A	24.08	855	8.16	-110.9	32.9	13.9	0.98	396	2570	257	0.13	0	0
WP04	22.15	853	7.89	-96.1	21.4	90.1	6.56	2267	466	1473	1.14	0	0
WTN01-D	18.93	855	8.38	-121.5	5.8	63	4.95	168	6711	109	0.05	0	1.2
WTN01-S	16.5	855	8.02	-102.2	-123	32	2.64	1107	1077	719	0.52	0	50.4
WTN02-S	22.9	854	8.58	-133	-109.7	12.7	0.91	162	6410	105	0.05	0	256
WWN01	22.03	849	8.21	-112.9	78	98.7	7.09	618	1715	401	0.26	0	0

APPENDIX C – WATER MONITORING GRAPHS

RECEIVING ENVIRONMENT GRAPHS

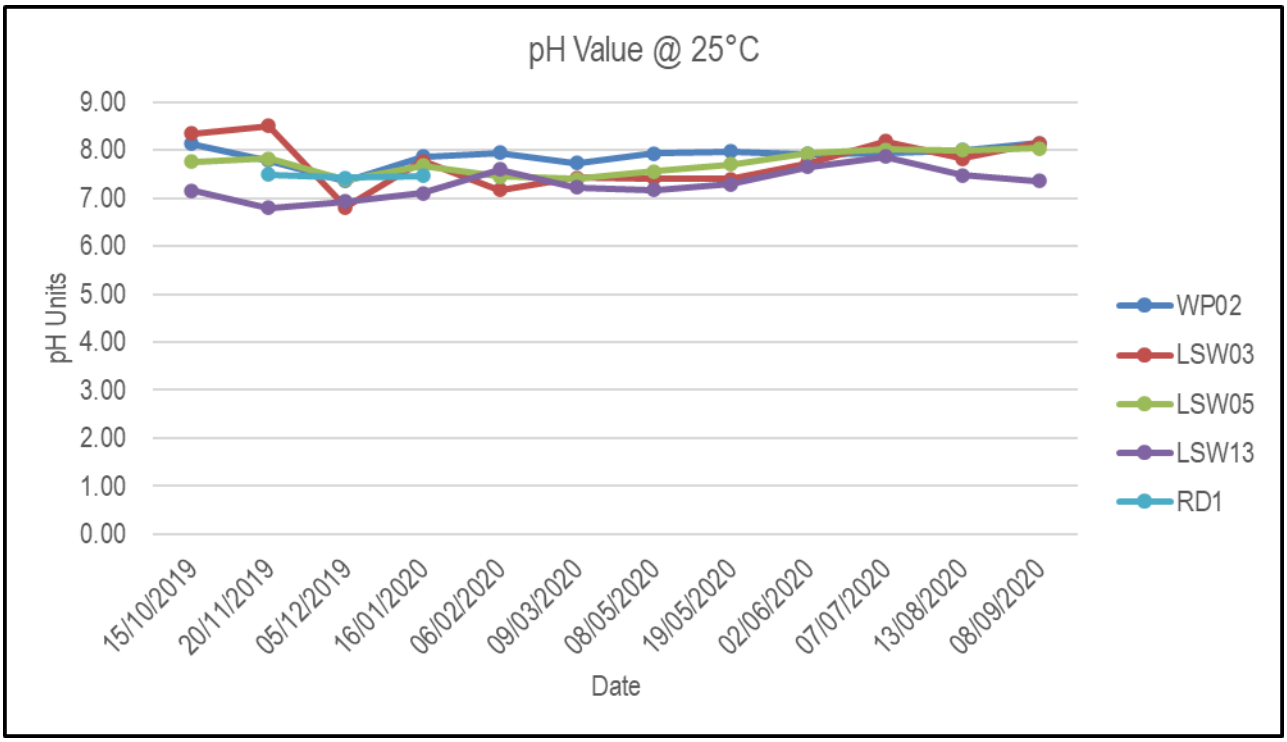


Figure 10: pH value

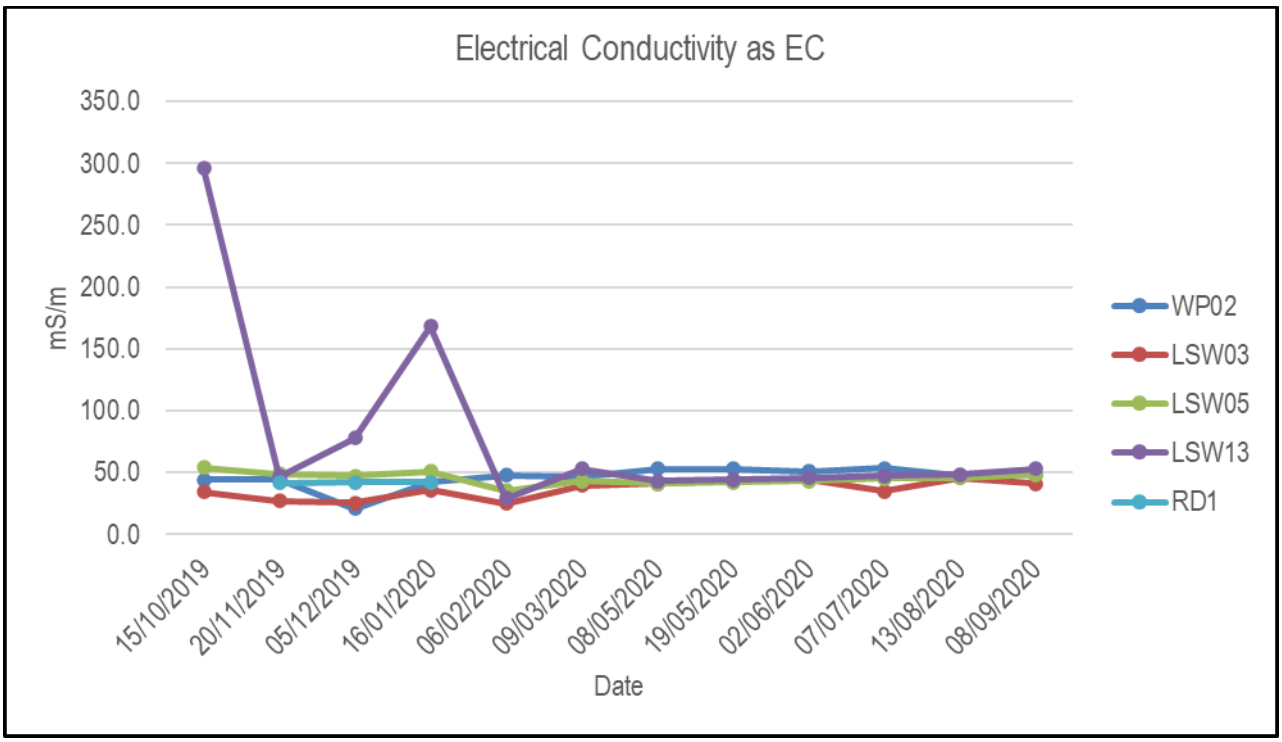


Figure 11: Electrical Conductivity

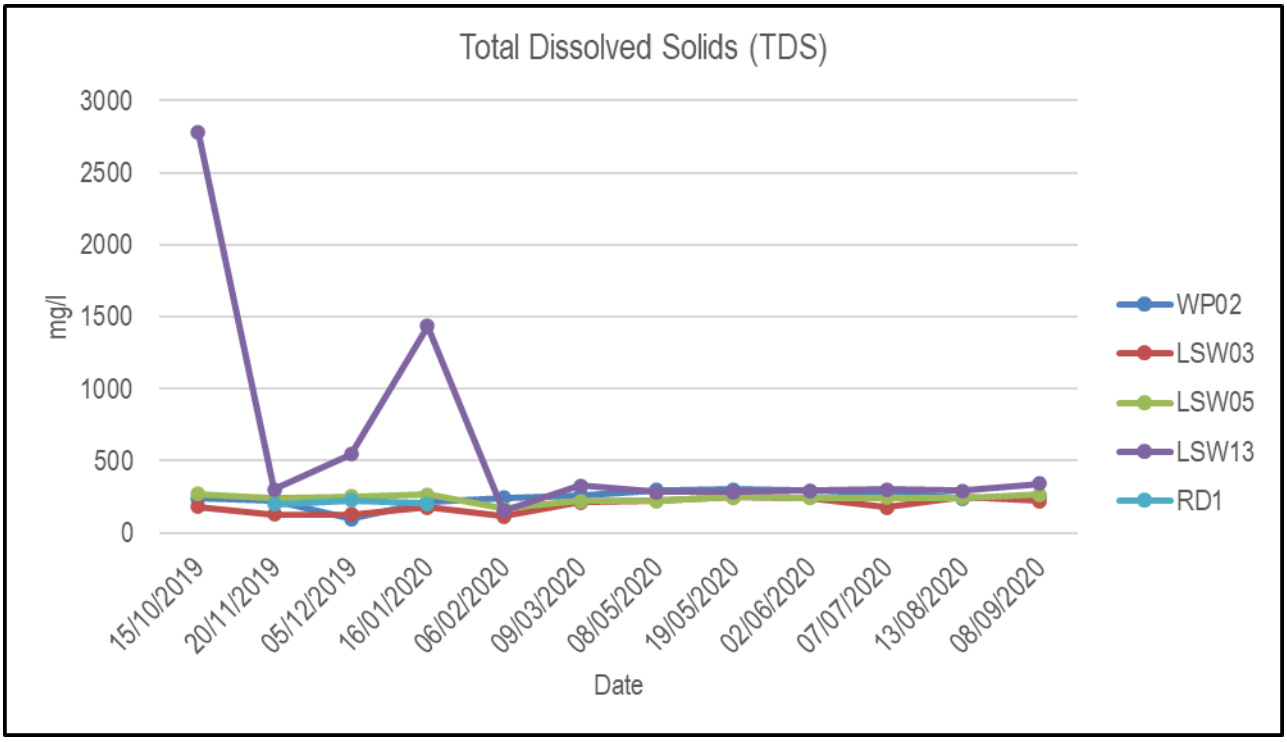


Figure 12: Total Dissolved Solids

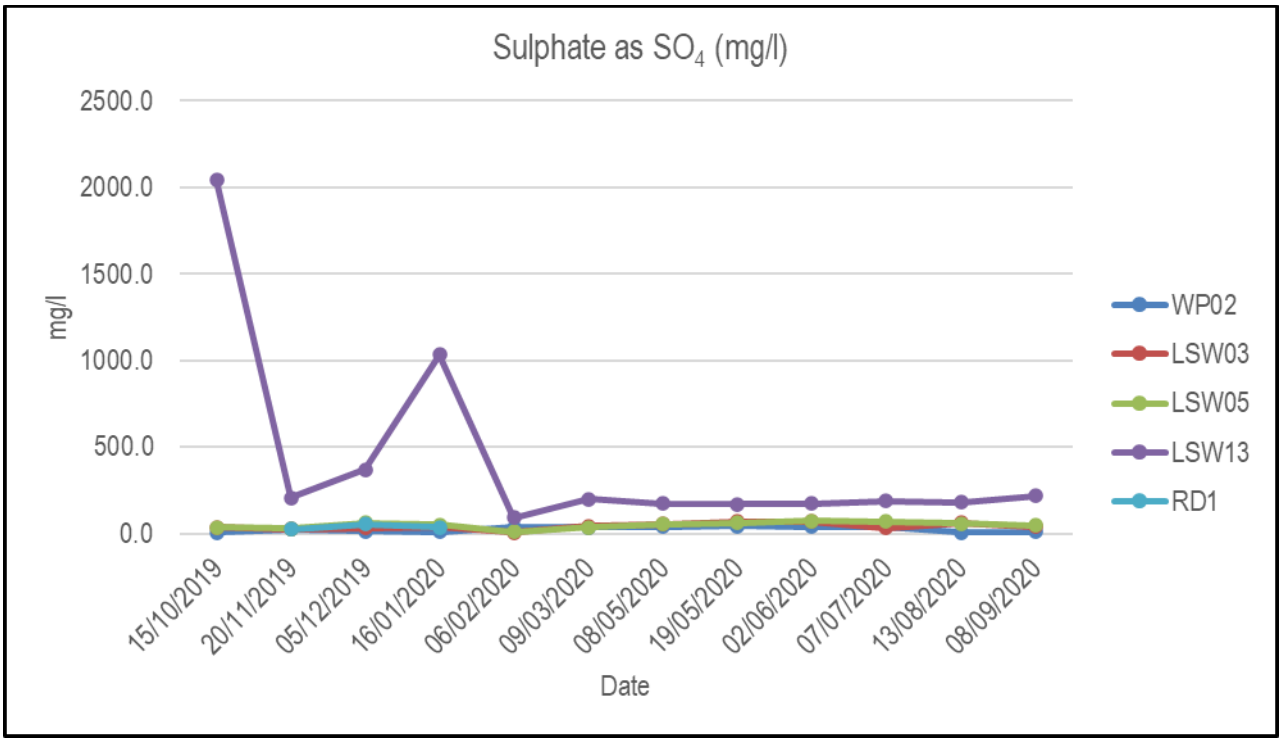


Figure 13: Sulphate

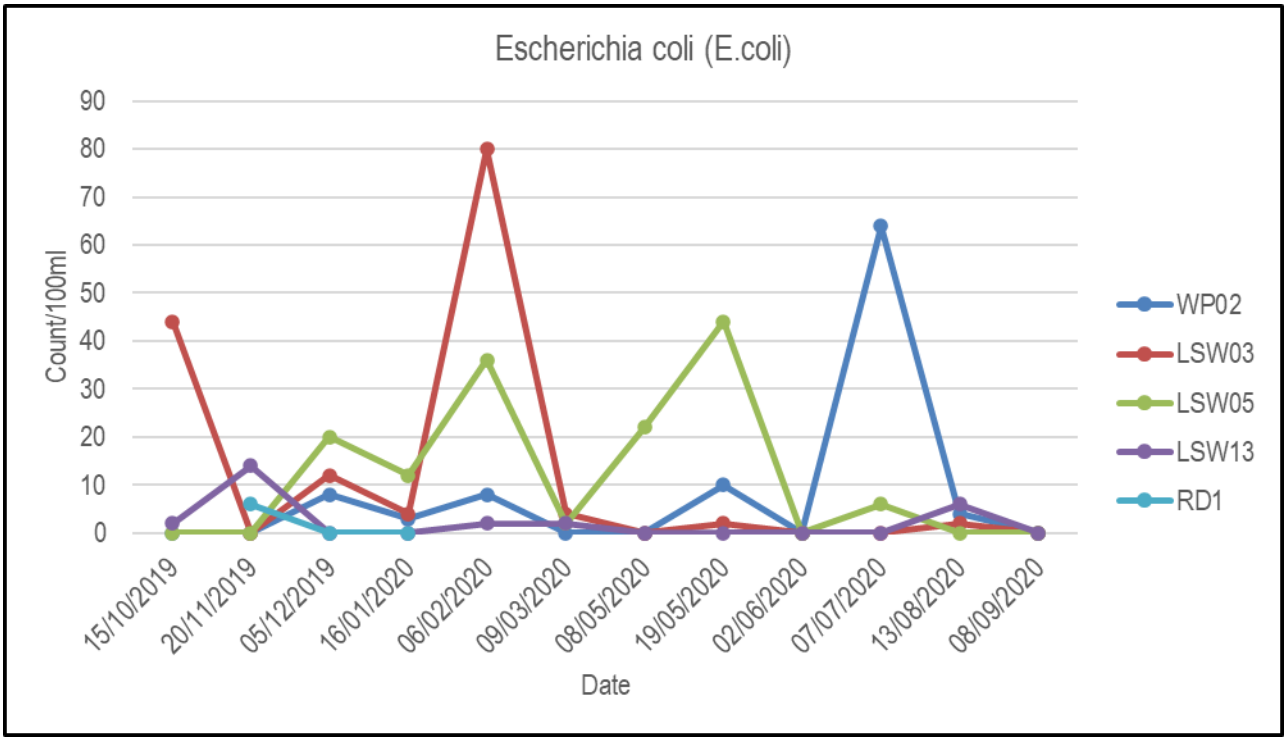


Figure 14: *Escherichia coli* (*E.coli*)

PROCESS WATER GRAPHS

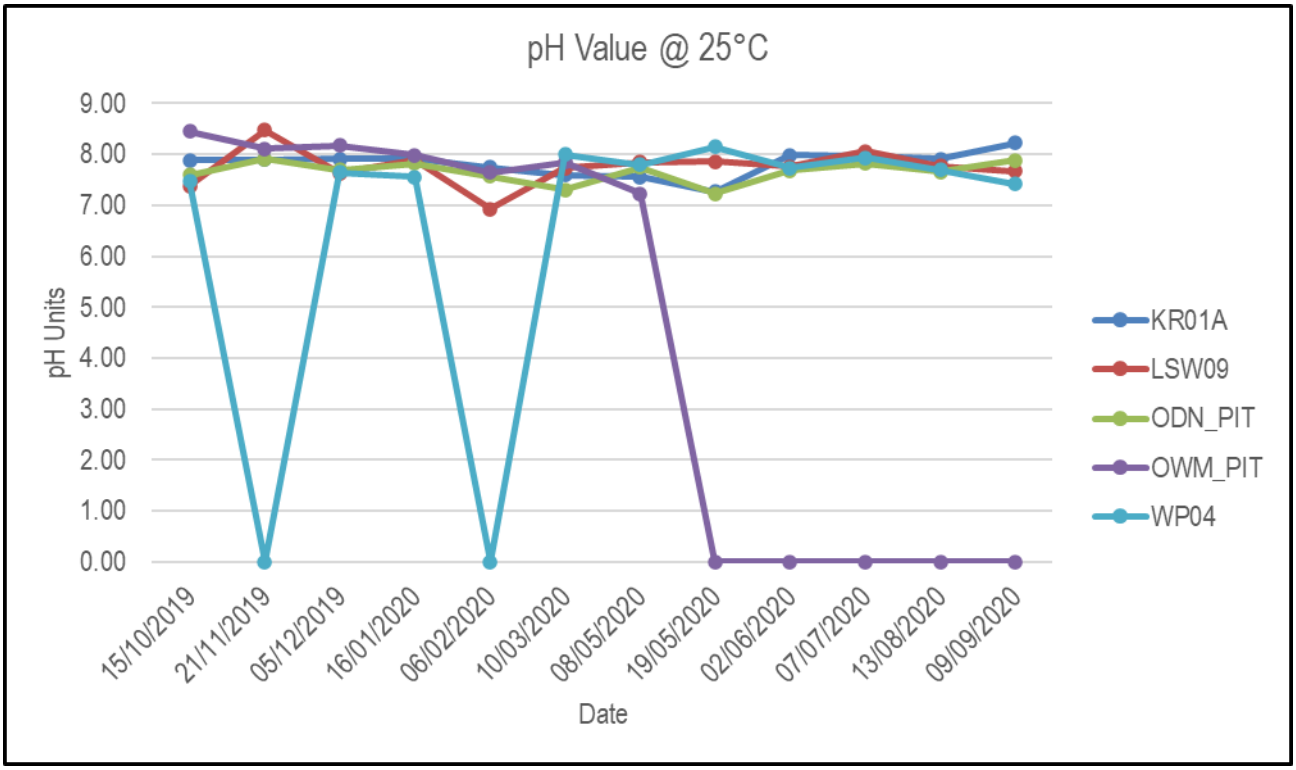


Figure 15: pH value

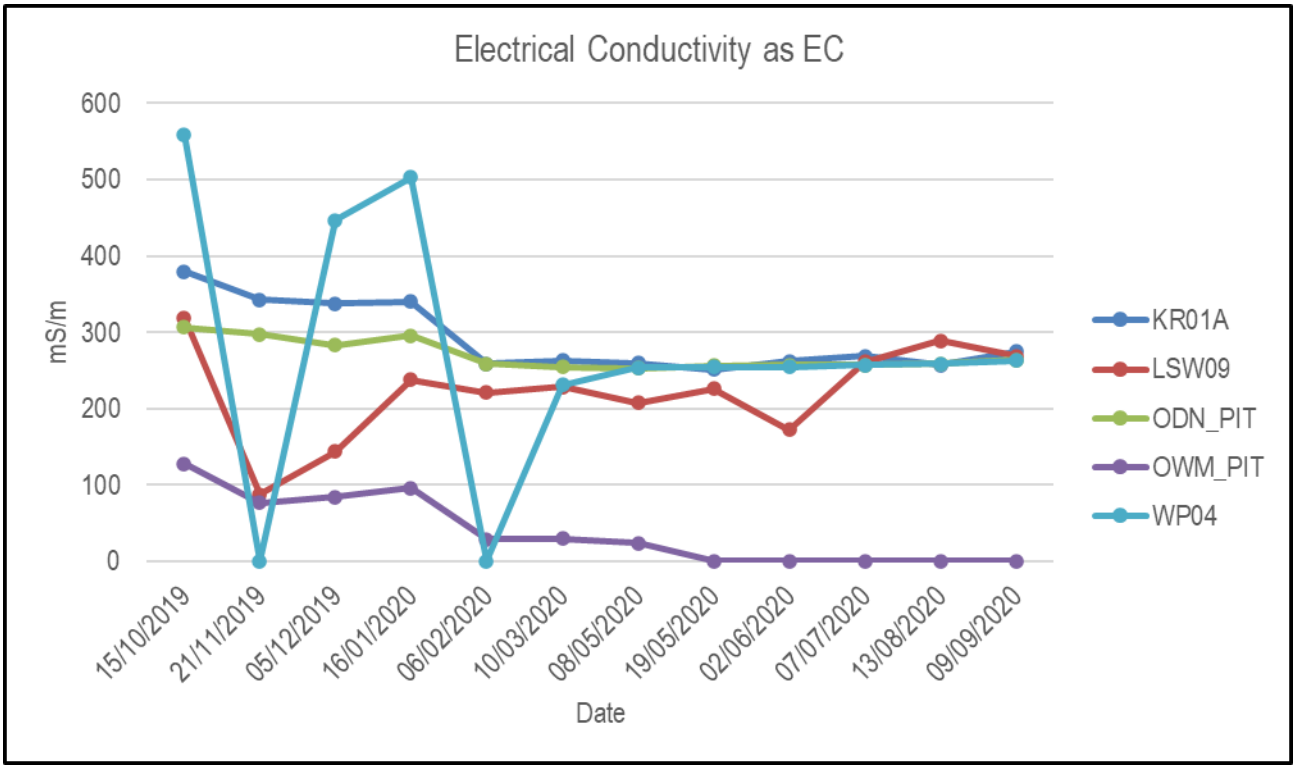


Figure 16: Electrical Conductivity

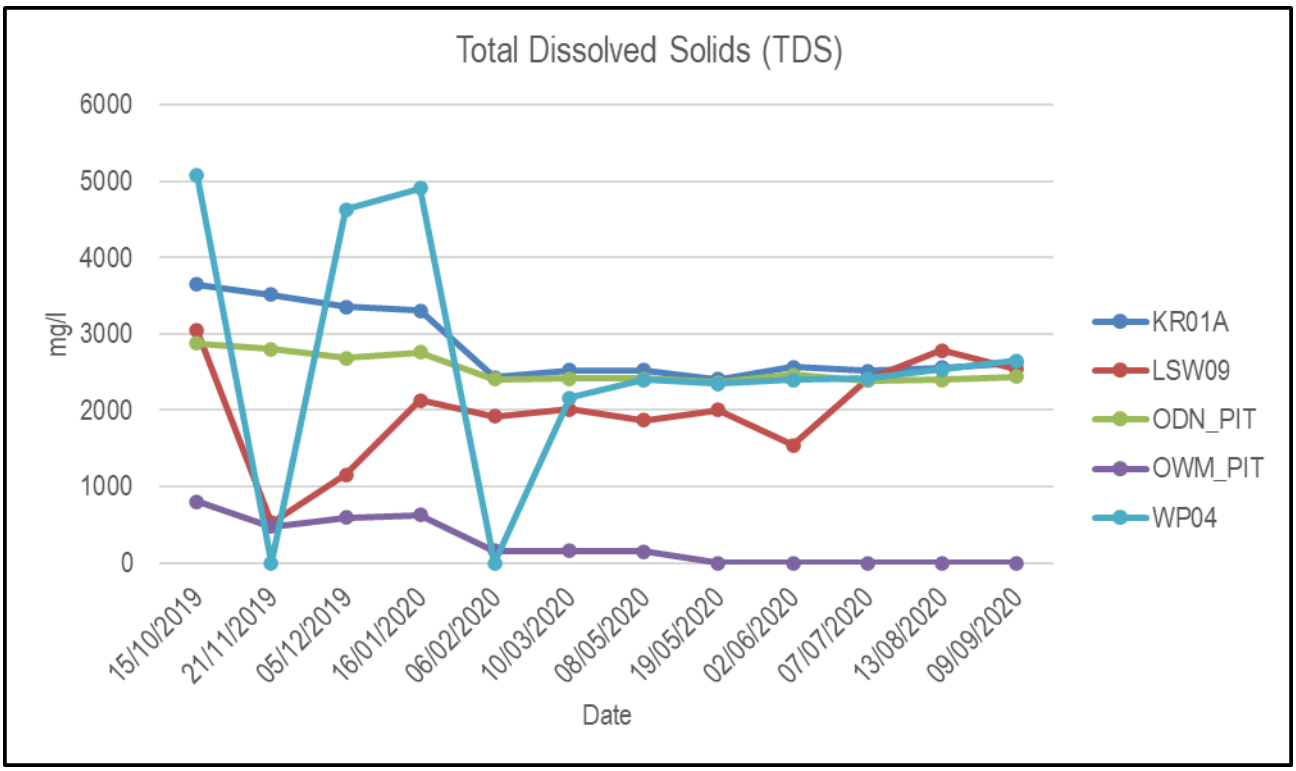


Figure 17: Total Dissolved Solids

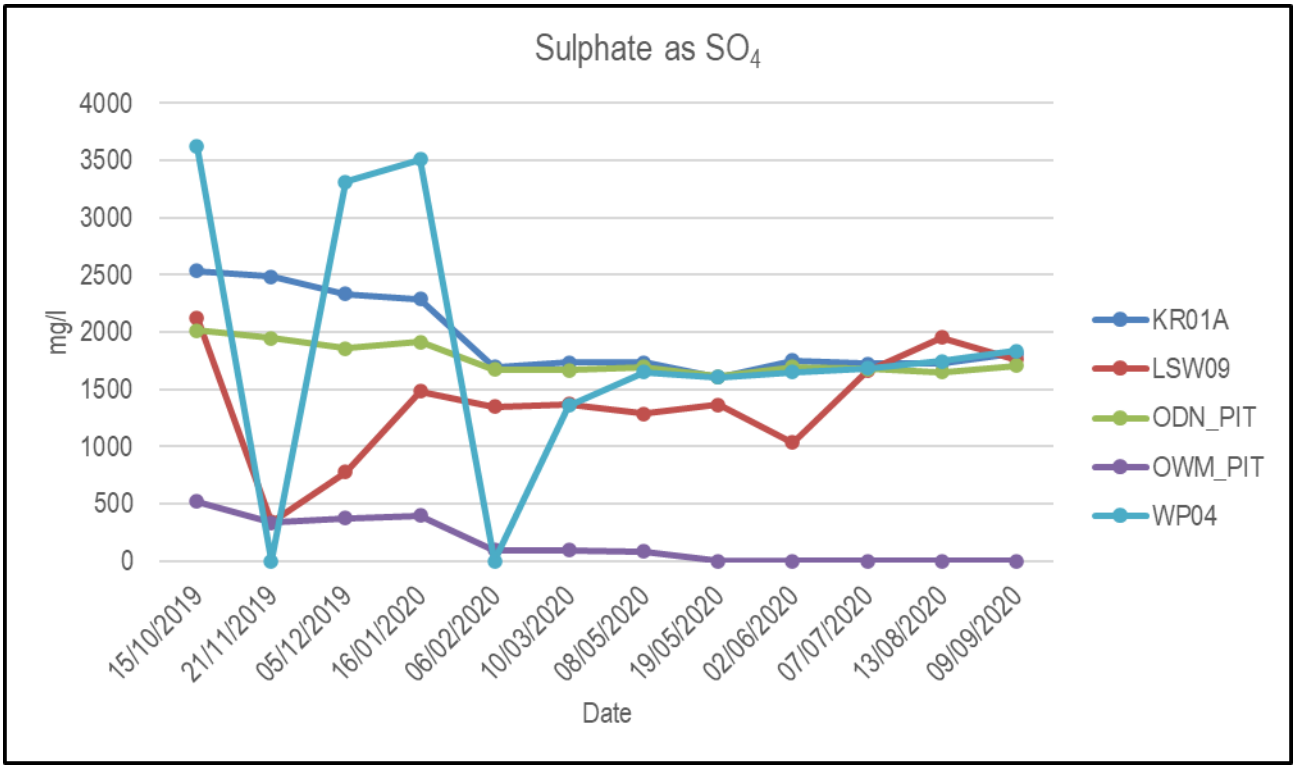


Figure 18: Sulphate

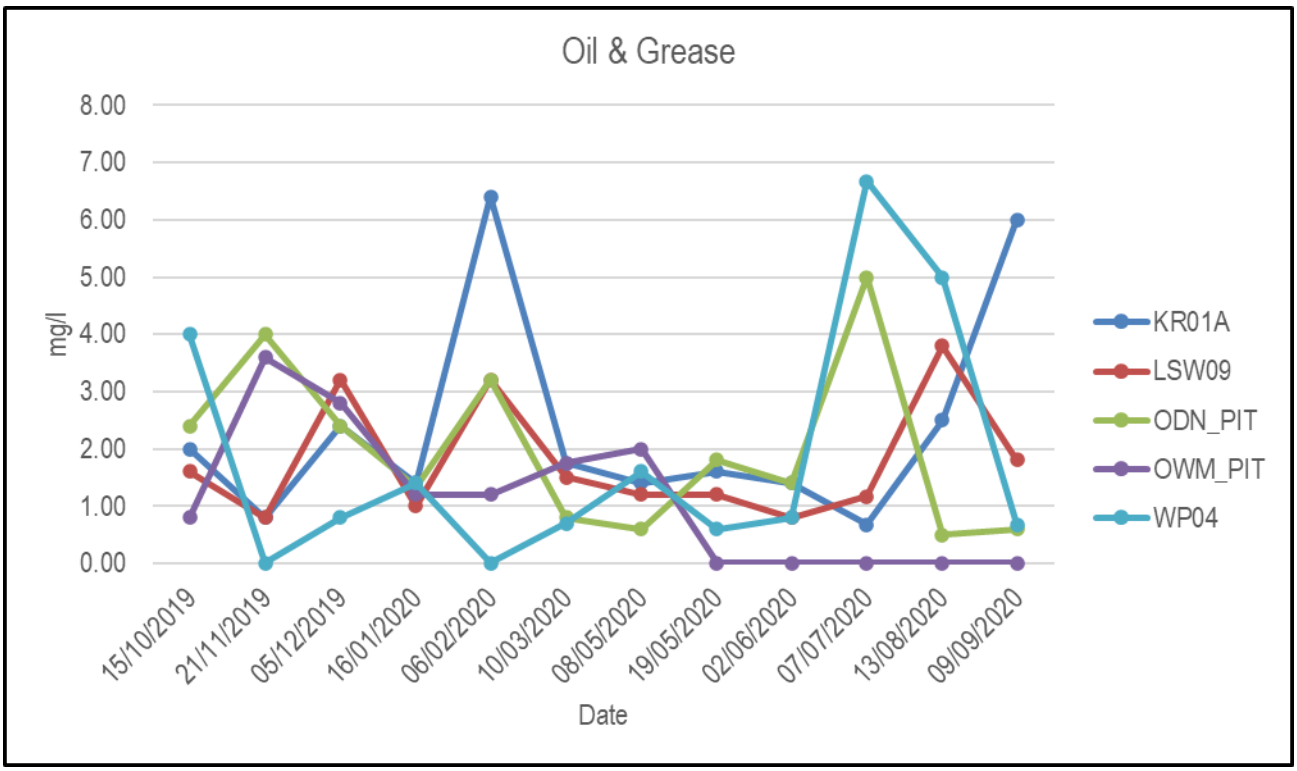


Figure 19: Oil and Grease

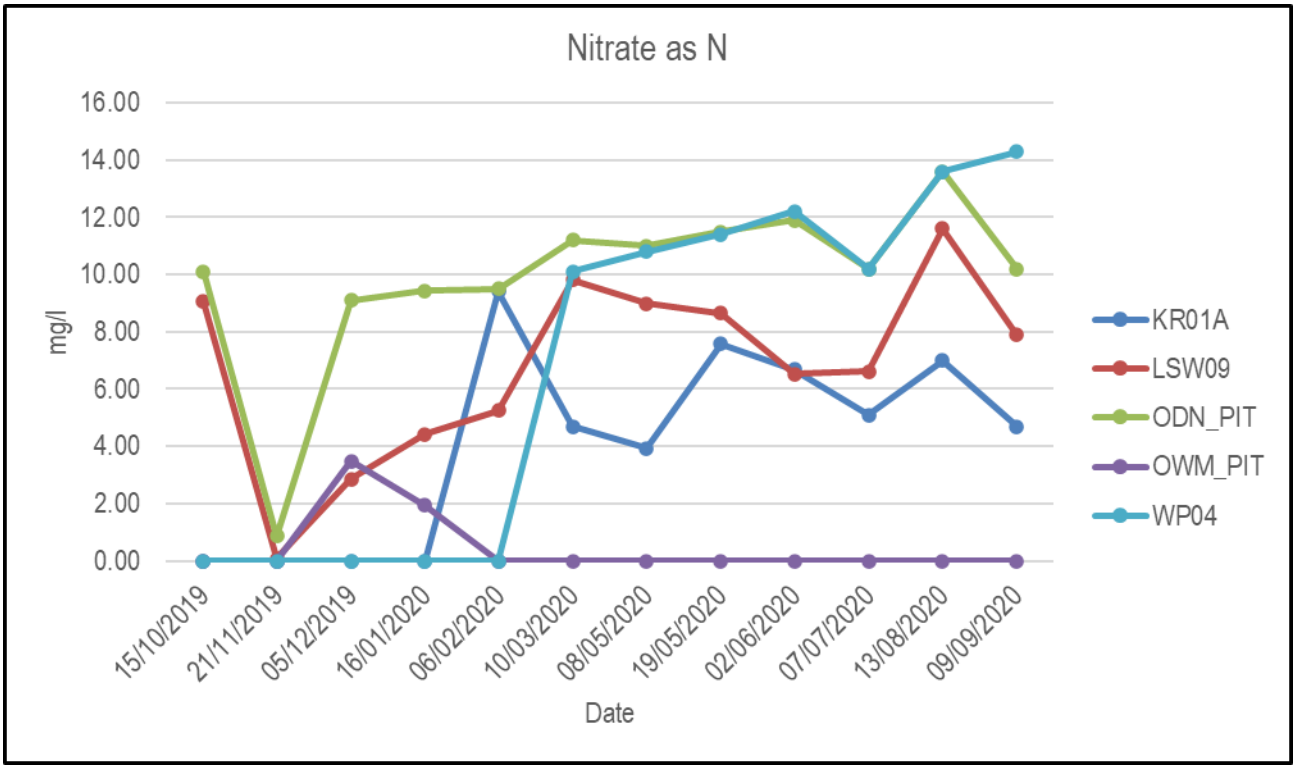


Figure 20: Nitrate

EFFLUENT WATER GRAPHS

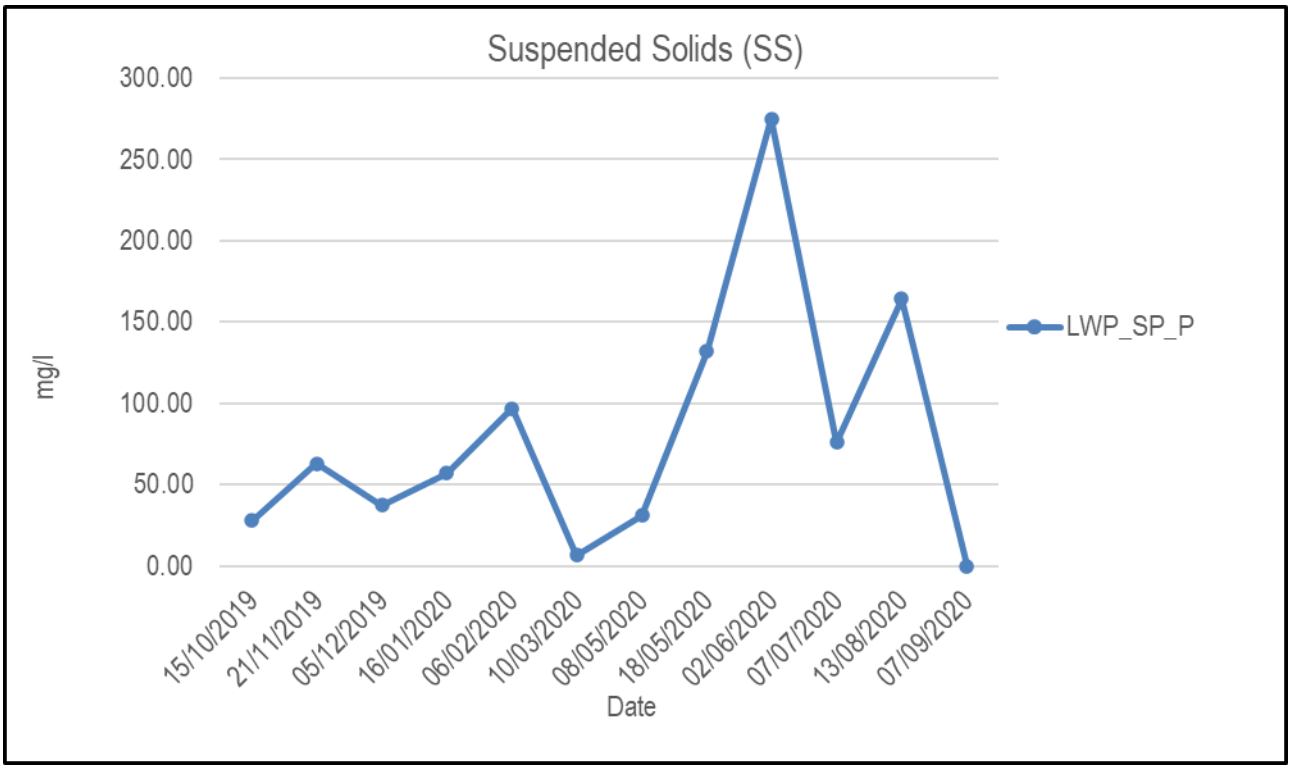


Figure 21: Suspended Solids

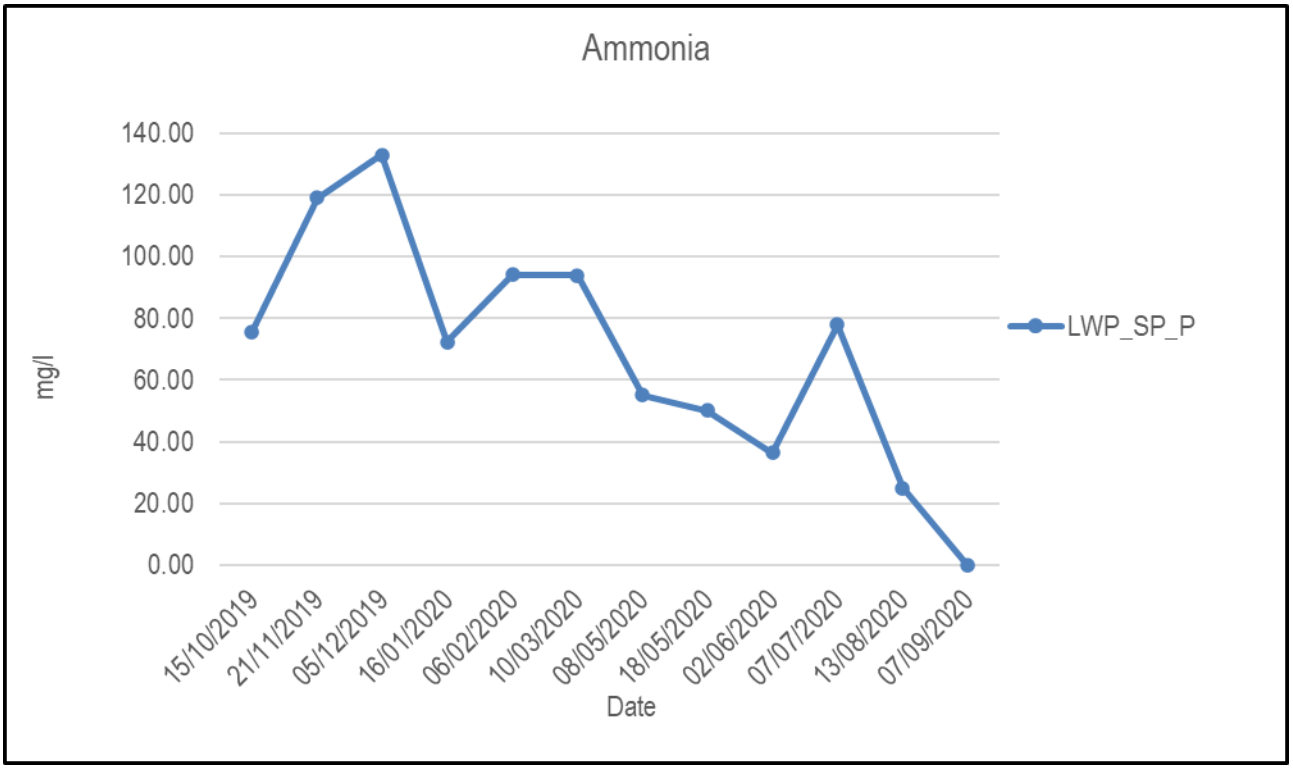


Figure 22: Ammonia

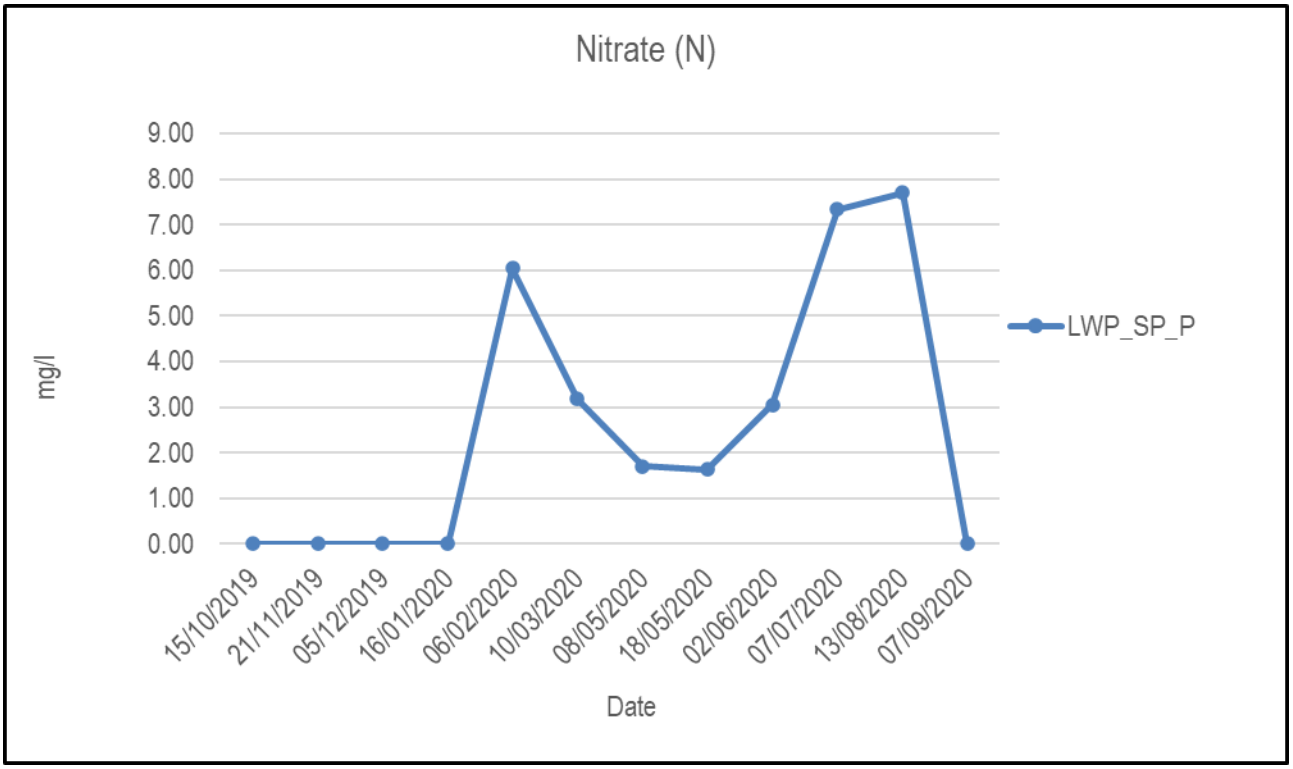


Figure 23: Nitrate

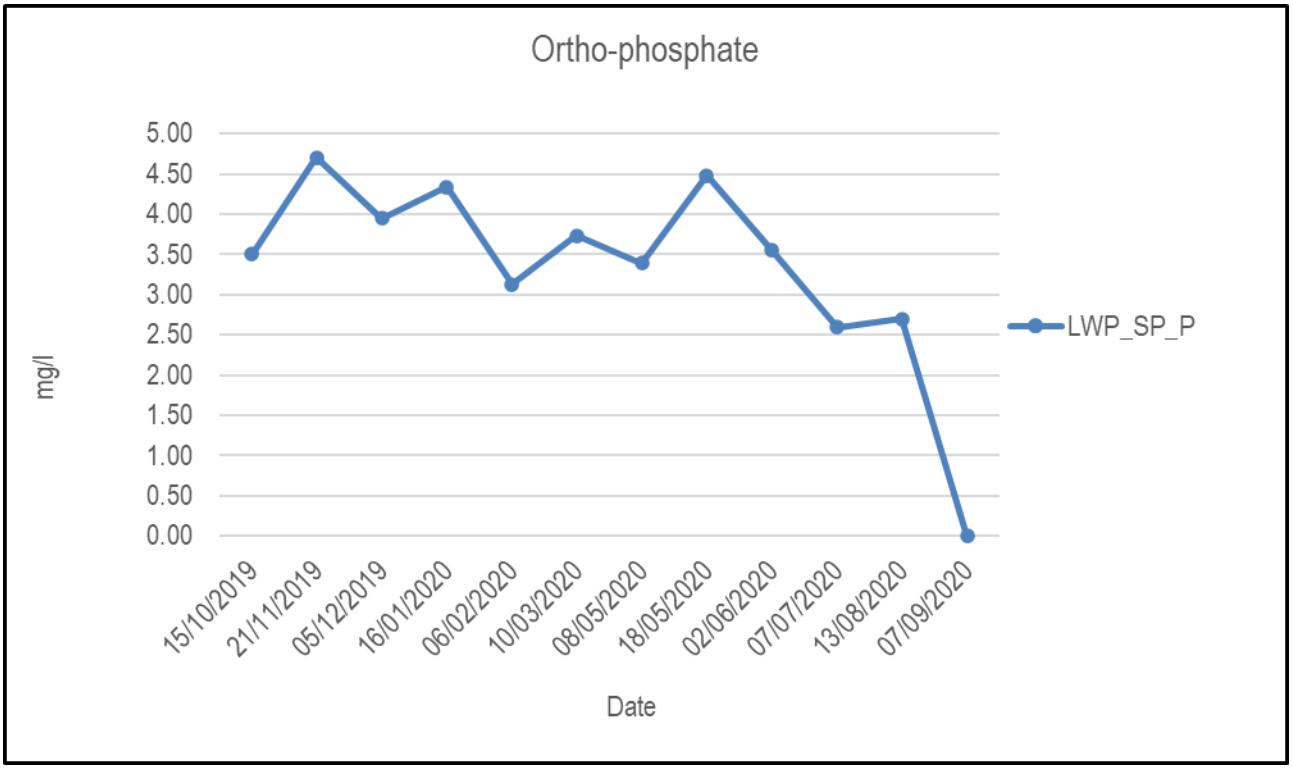


Figure 24: Ortho-Phosphate

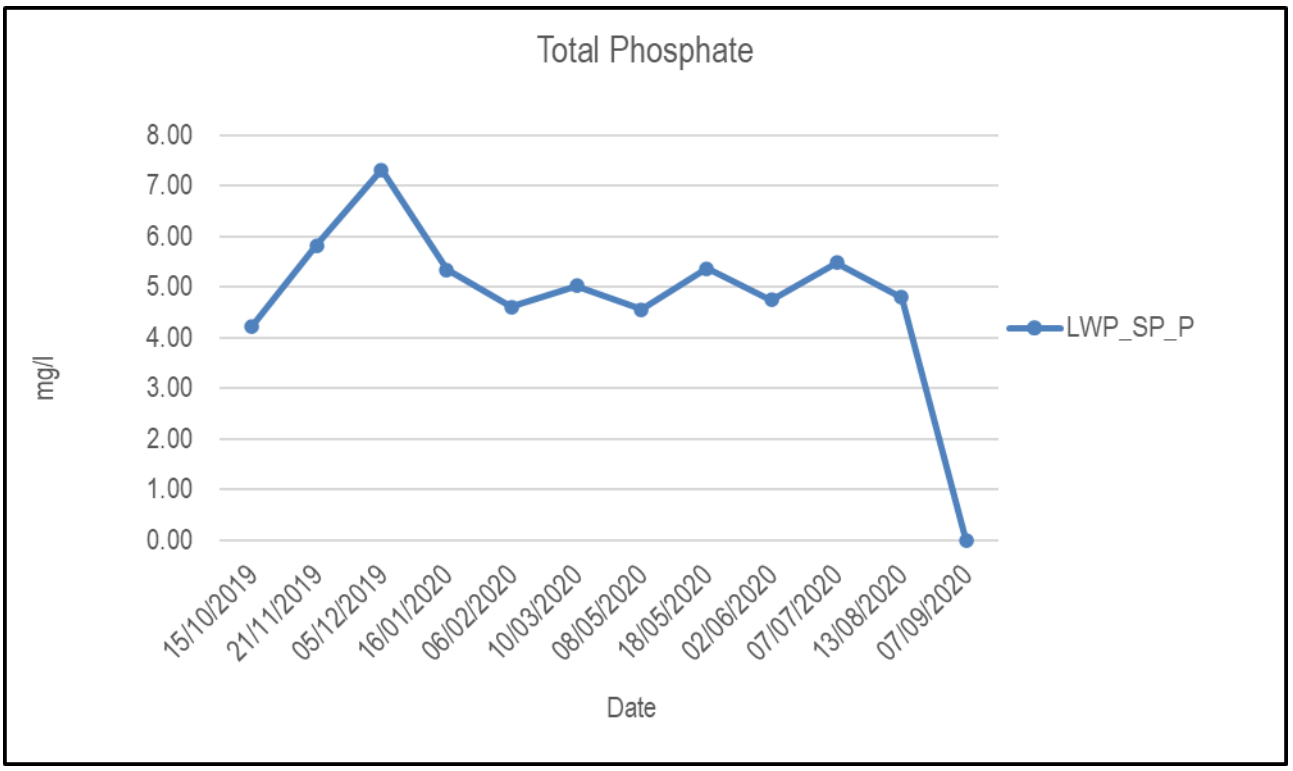


Figure 25: Total Phosphate

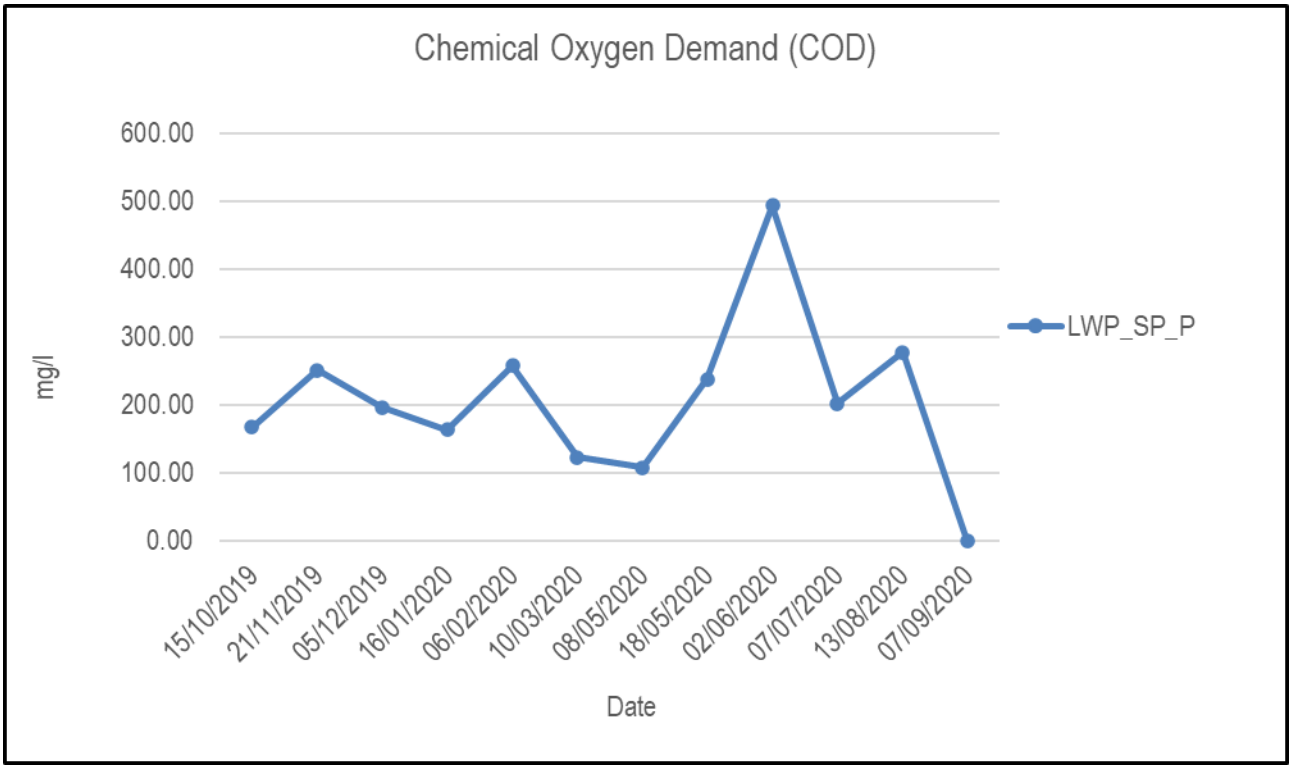


Figure 26: Chemical Oxygen Demand (COD)

POTABLE WATER GRAPHS

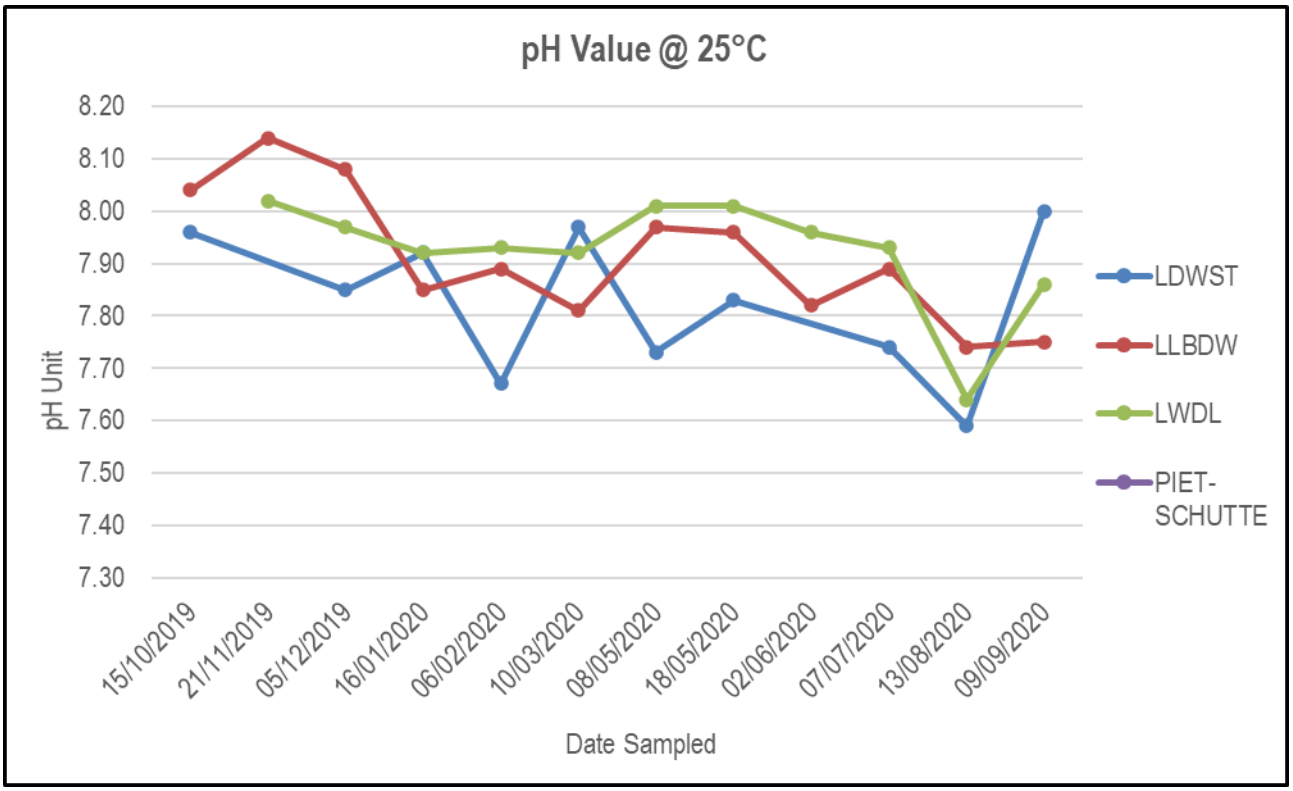


Figure 27: pH value

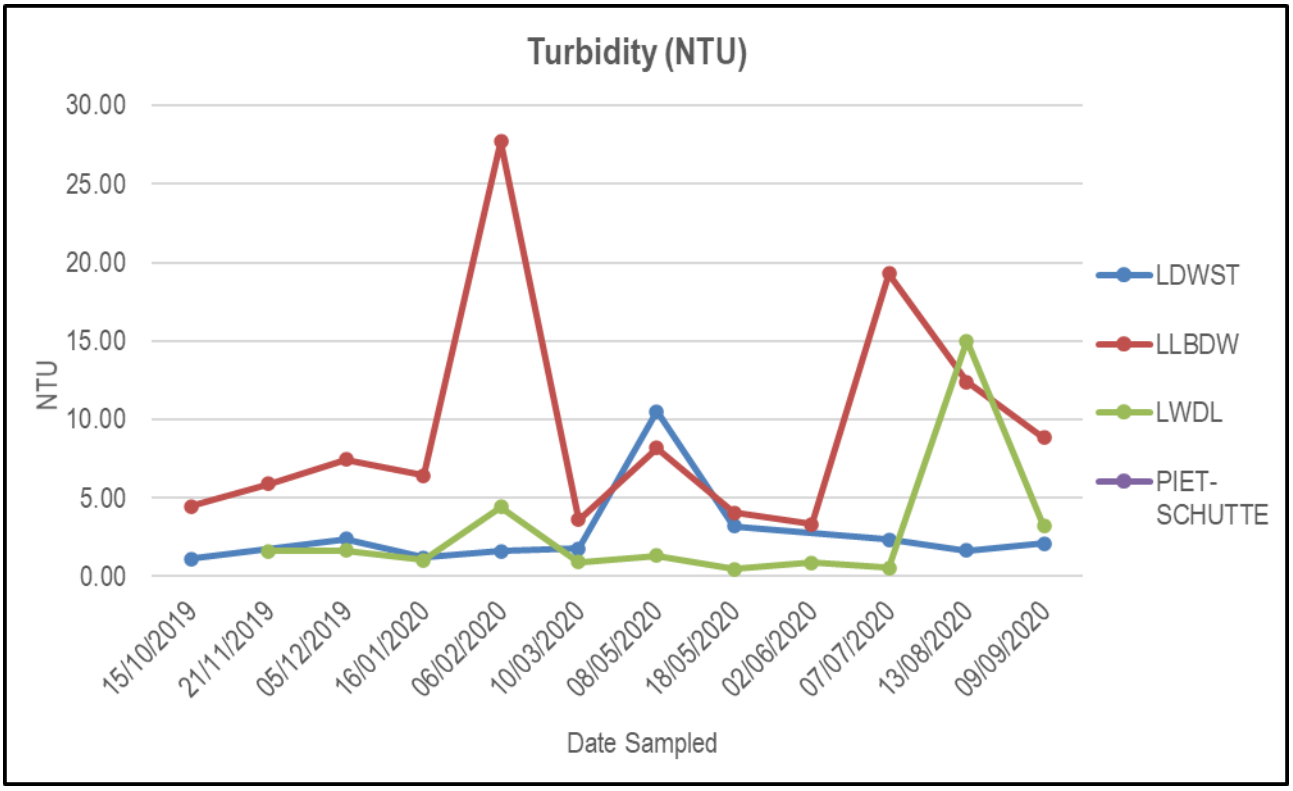


Figure 28: Turbidity

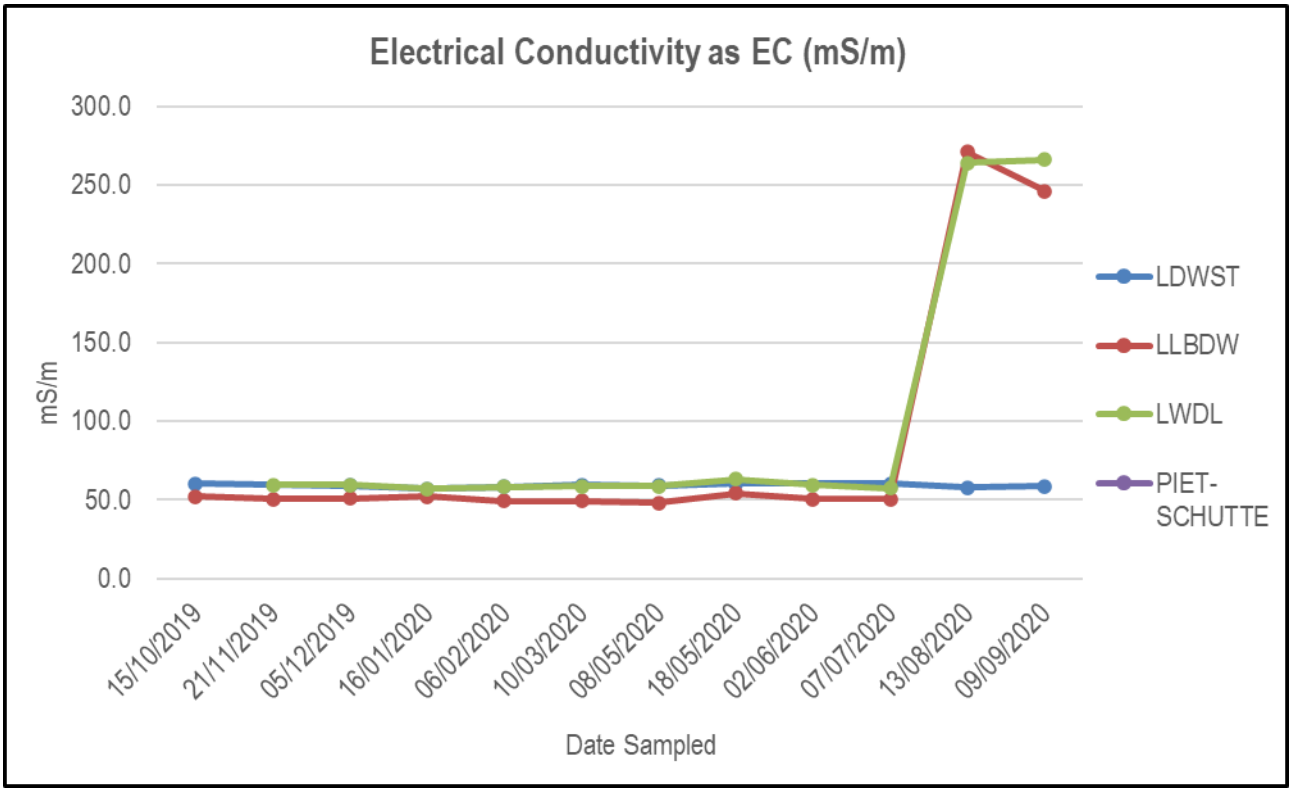


Figure 29: Electrical Conductivity

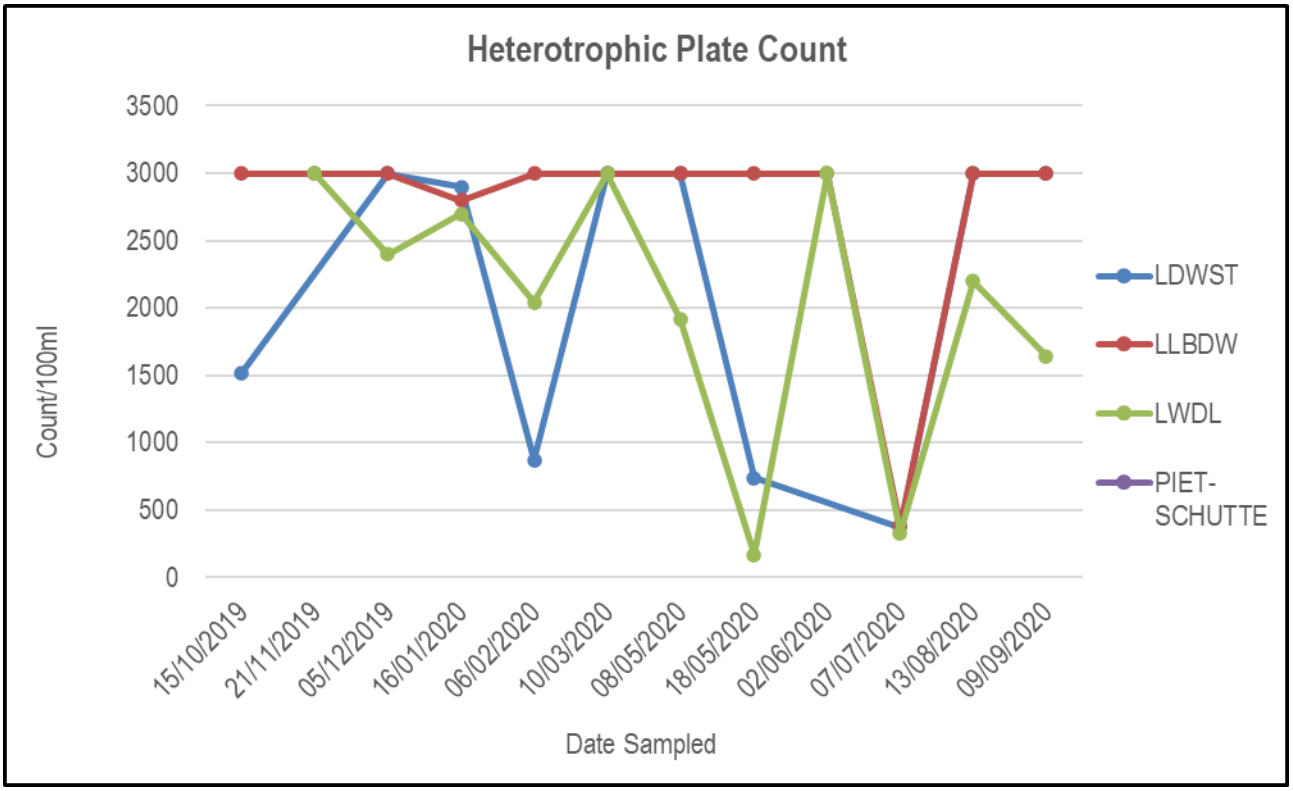


Figure 30: Heterotrophic Plate Count

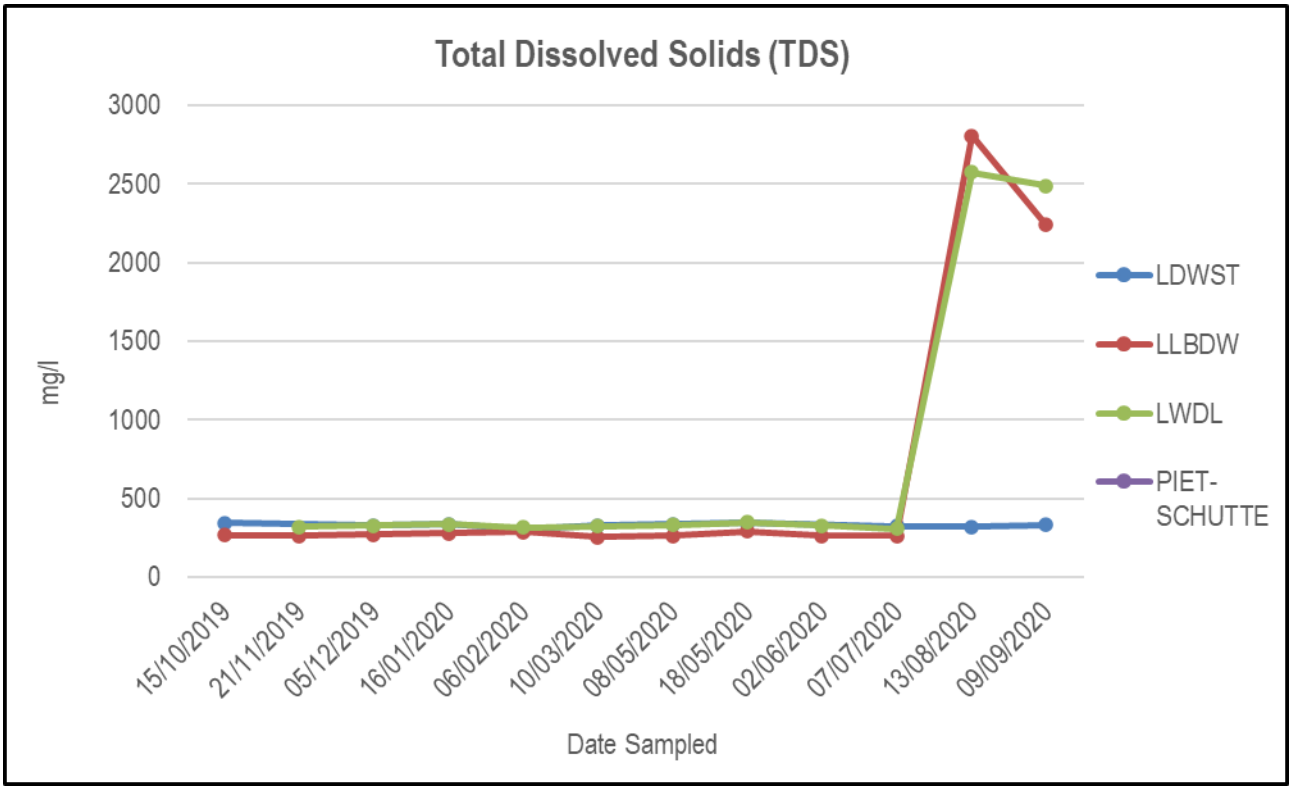


Figure 31: Total Dissolved Solids

GROUNDWATER GRAPHS

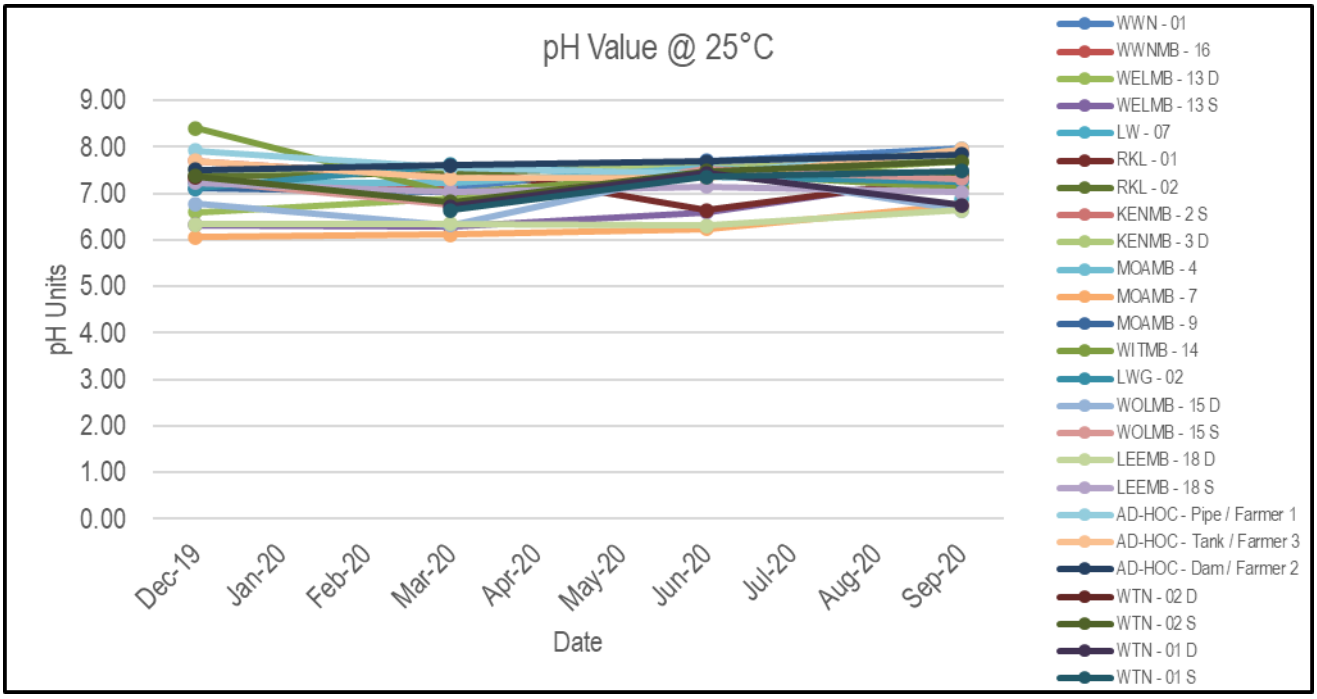


Figure 32: pH Value

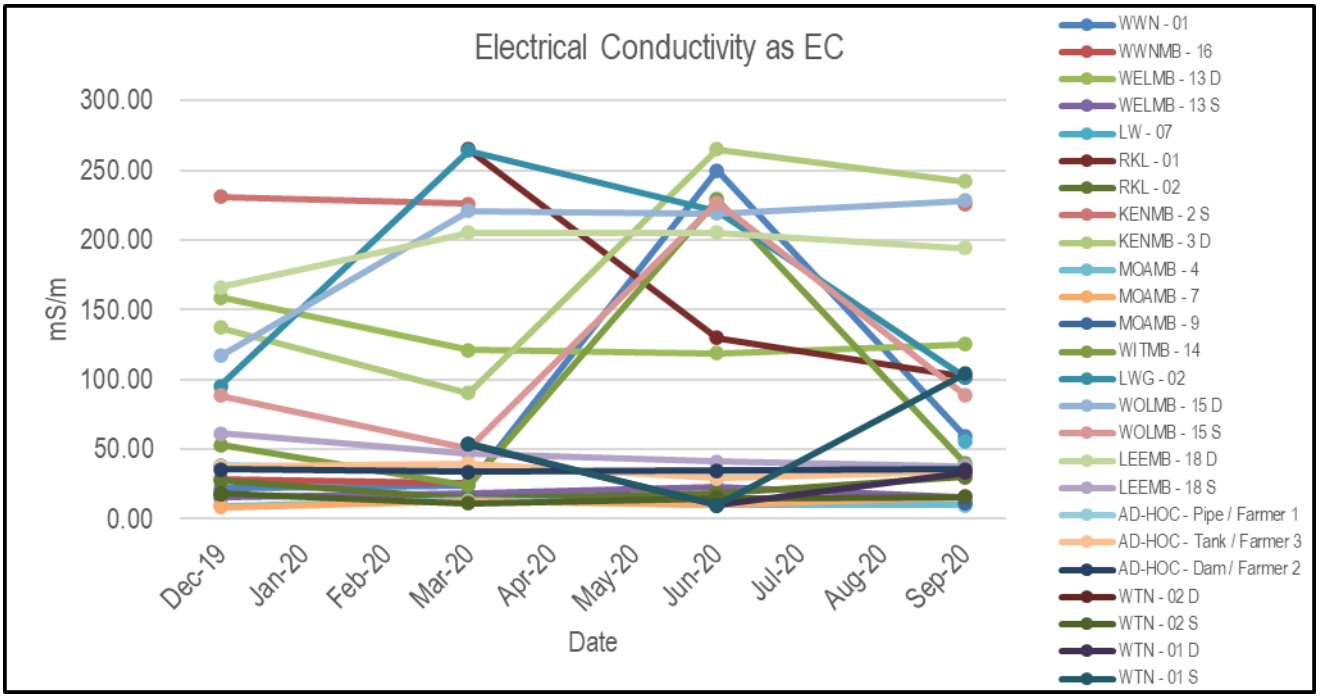


Figure 33: Electrical Conductivity

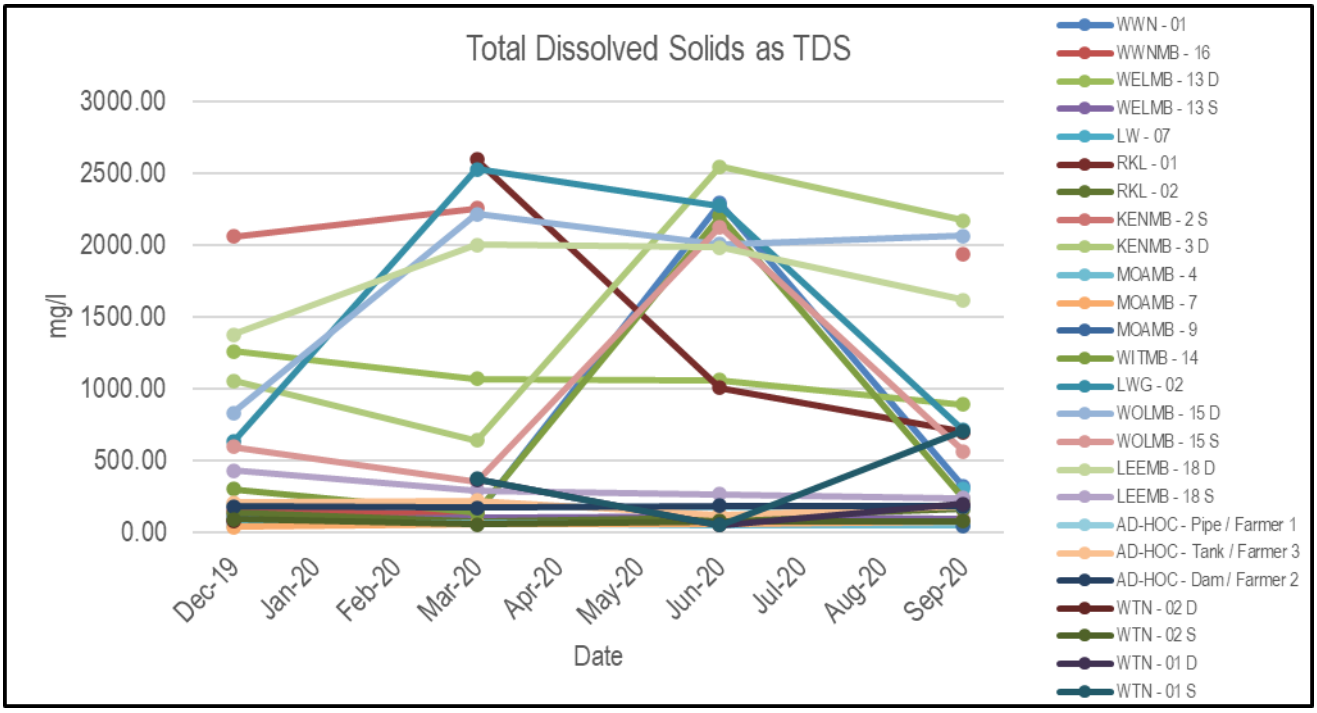


Figure 34: Total Dissolved Solids (TDS)

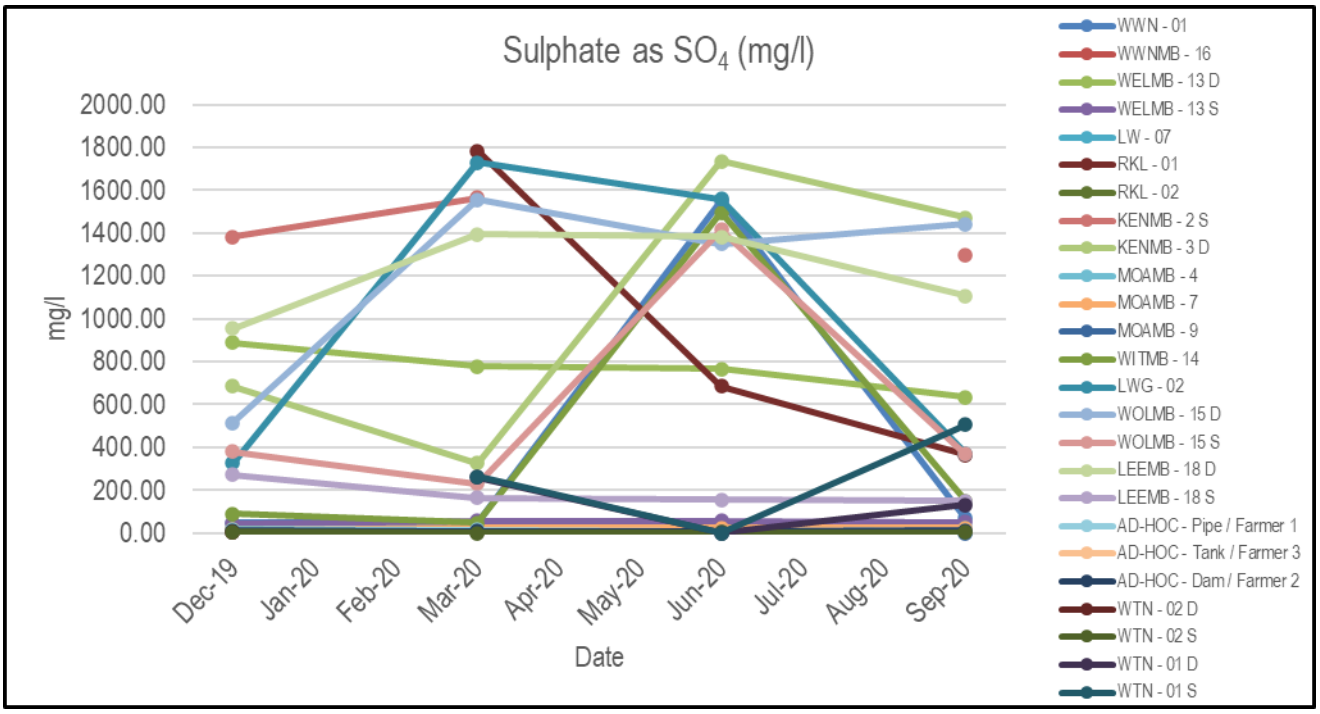


Figure 35: Sulphates as SO_4